Draft Final

Operable Unit 1 Focused Feasibility Study for the LNAPL Source Area

for the

Diamond Head Oil Superfund Site Kearny, New Jersey

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Contents

Appendices

Tables

Figures

Abbreviations and Acronyms

ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
bgs	below ground surface
CERCLA	Comprehensive Environmental Remediation, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	contaminant of potential concern
CLP	Contract Laboratory Program
cm/s	centimeters per second
CY	cubic yard
DRO	diesel range organic
FFS	focused feasibility study
FML	flexible membrane liner
FR	*Federal Register*
FS	feasibility study
ft^2	square feet
gpm	gallons per minute
GRA	general response action
GRO	gasoline range organic
I	Interstate
IGWSCC	Impact to Groundwater Soil Cleanup Criteria
KMUA	Kearny Municipal Utilities Authority
LDR	land disposal restriction
LIF	laser induced fluorescence
LNAPL	light nonaqueous phase liquid
mg/L	milligrams per liter
MM Btu	million British thermal units
MSLA	Municipal Sanitary Landfill Authority
MUA	Municipal Authority
NCP	National Contingency Plan
NJAC	New Jersey Administrative Code

NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NPL	National Priorities List
O&M	operations and maintenance
OMB	Office of Management and Budget
OU1	Operable Unit 1
PCB	polychlorinated biphenyl
POTW	publicly owned treatment works
PRG	preliminary remedial goal
psi	pounds per square inch
PVSC	Passaic Valley Sewerage Commission
SPLP	synthetic precipitate leachate procedure
SVOC	semivolatile organic compound
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
% RE	percent Reference Emitter
RI	remedial investigation
ROD	Record of Decision
RTA	Remedial Target Area
SARA	Superfund Amendments and Reauthorization Act
SF	square feet
SOTA	state-of-the-art
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
TMV	toxicity, mobility, or volume
TSS	total suspended solids
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UTS	Universal Treatment Standards
VOC	volatile organic compound

SECTION 1

Introduction

This draft final focused feasibility study (FFS) report was prepared for the United States Environmental Protection Agency (USEPA) Region 2 as part of Task Order 0002 under Contract W912DQ-08-D-0016 with the Kansas City District of the United States Army Corps of Engineers (USACE). This FFS report presents the development and evaluation of remedial action alternatives for undertaking an early remedial action for the principal threat light nonaqueous phase liquid (LNAPL) source zone, which is part of Operable Unit 1 (OU1) at the Diamond Head Superfund site. USEPA, in consultation with the New Jersey Department of Environmental Protection (NJDEP), and with public input, will use the information presented in this FFS report to select, in accordance with 40 Code of Federal Regulations (CFR) 300, the Early Action Alternative in the Record of Decision (ROD) for the site.

Two phases of remedial investigations (RIs) have been completed at the site. The objective of the first phase of RI activities completed in 2003 was to gain an overall understanding of the chemical and LNAPL contamination found at the site. The Phase 1 RI results, presented in the final Phase 1 RI technical memorandum (CH2M HILL 2005), identified significant LNAPL presence at the site. This LNAPL presence likely serves as a source material continuing to release chemical contaminants to the various media at the site. Based on the Phase 1 results, USEPA determined that it was appropriate for the site to be divided into two OUs with the LNAPL source material being addressed through an Early Remedial Action as part of OU1.

Based on this determination, the next phase of RI activities focused on investigating the nature and extent of LNAPL contamination (focused Phase 2 RI of OU1) and obtaining the necessary information to support an FFS of remedial action alternatives for the Early Action. The final Phase 2 RI technical memorandum describes the LNAPL presence at the site (CH2M HILL 2009).

This section of the FFS report comprises the following subsections:

- Purpose of the FFS report
- Organization of the FFS report
- Definitions
- Site background and history
- OU1 RI/feasibility study (FS) objectives
- Nature and extent of LNAPL source material
- Principal threat evaluation

FFS Report Purpose

This FFS report documents the development and evaluation of remedial action alternatives for undertaking an Early Remedial Action for the principal threat LNAPL source material found at the Diamond Head site. Specifically, this FFS report summarizes site background information (Section 1), develops remedial objectives and preliminary remediation goals, defines LNAPL that is considered to represent the principal threat, and delineates the associated remedial target area (Section 2); presents the results of technology screening and evaluation and the development of remedial alternatives (Section 3); and presents the detailed evaluation of the developed remedial alternatives including a comparative analysis of alternative performance (Section 4).

This FFS is based on data collected during the Phase 1 and 2 RIs at the site. Therefore, this FFS report must be viewed within the limits of available data and is not intended to be a design document. Rather, the report gives a conceptual overview of alternatives and evaluates their feasibility relative to the nine evaluation criteria defined by the National Contingency Plan (NCP) (40 CFR Part 300). Additional pre-design data collection activities would be needed to support the detailed design of the selected remedial action alternative. Bench-scale and/or full-scale treatability studies may also be needed prior to full-scale system design.

The criteria for remedy selections under the Comprehensive Environmental Remediation, Compensation, and Liability Act (CERCLA) establish the following five principal requirements for the selection of a remedy:

- Protect human health and the environment
- Comply with applicable or relevant and appropriate requirements (ARARs) of federal and state environmental laws within a reasonable timeframe
- Be cost-effective
- Use permanent solutions and alternative treatment technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces contaminant toxicity, mobility, or volume (TMV)

The goal of the remedy selection process, as stated in 40 CFR 300.430 (a)(1)(i), is to select remedies that protect human health and the environment, that maintain protection over time, and that minimize untreated waste. The NCP describes USEPA's expectations for developing remedial alternatives consistent with 40 CFR 300.430(a)(1)(iii)(A–F) and includes the following requirements applicable to the Early Action that USEPA is looking to undertake at the Diamond Head site:

- Use treatment to address the principal threats posed by a site, wherever practicable
- Use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable
- Use a combination of methods, as appropriate, to achieve protection of human health and the environment
- Use institutional controls, such as water use and deed restrictions, to supplement engineering controls as appropriate, for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants or contaminants
- Consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, fewer or lesser adverse impacts than other available approaches, or lower costs for similar levels of performance, than demonstrated technologies

In addition, USEPA has developed nine criteria for evaluating remedial alternatives to ensure that all important considerations are factored into remedy selection decisions. The nine-criterion analysis comprises two steps: (1) an individual evaluation of each alternative with respect to each criterion, and (2) a comparison of options to determine the relative performance of the alternatives through an evaluation of relative advantages and disadvantages.

As described in USEPA guidance (USEPA 1988) and in 40 CFR 300, this FFS consists of developing and evaluating remedial alternatives for the Early Action to address the principal threat LNAPL source zone at the site, including a comparative analysis of alternatives.

The following steps were used in developing the remedial alternatives for the site:

1. Identify ARARs
2. Develop remedial action objectives (RAOs)
3. Define remedial action goals, including the following:
   - Developing preliminary remedial goals (PRGs)
   - Identifying areas of contamination exceeding PRGs
4. Develop general response actions
5. Identify, screen, and evaluate technologies (including innovative technologies)
6. Assemble remaining process options into remedial alternatives
7. Evaluate the remedial alternatives in accordance with 40 CFR 300, including comparative analysis of their performance relative to the nine criteria

It should be noted that baseline human health and ecological risk assessments have not been completed for the site at the time of preparation of this FFS. Since the intent of the FFS is to address the source material (i.e., LNAPL) in the subsurface soils, these baseline risk assessments are not needed at this time (please refer to page 7 of "Role of the Baseline Risk Assessment", EPA 1991, http://www.epa.gov/oswer/riskassessment/pdf/baseline.pdf). Instead, this FFS discusses the risks associated with the source material and how the temporary measures included in the early action will address the portion of the risk associated with this material. Following the early action, the RI/FS for the complete OU1 will be performed and will include the assessments of the baseline human health and ecological risks. The subsequent ROD for the complete OU1 based on the complete RI/FS, will follow the interim action ROD and document the long-term protection of human health and the environment for the site.

FFS Report Organization

This FFS report consists of five sections:

- Section 1, *Introduction*: Presents the purpose of this FFS and a general description of the site, its history, and the extent and nature of the LNAPL contamination identified during the OU1 activities. This section also describes the LNAPL source material, including the LNAPL contamination considered to represent a principal threat and the contamination considered to represent a low level threat. A brief description is also provided of investigation activities performed during the Phase 2 RI that were not related to the LNAPL contamination at the site (e.g., the investigation of the onsite landfill).

- Section 2, *Development and Identification of ARARs, RAOs, and PRGs*: Summarizes the ARARs; the developed site-specific RAOs, including PRGs; and the areas and volumes of the media requiring remedial action based on these PRGs.
- Section 3, *Identification, Screening, and Evaluation of Remedial Technologies*: Describes the general response actions established for LNAPL, identifies remedial technologies applicable to LNAPL contamination, and evaluates their applicability to site conditions. The remedial technologies determined to be applicable are then assembled into remedial action alternatives.
- Section 4, *Detailed Analysis of Remedial Action Alternatives*: Presents the detailed evaluation of the remedial action alternatives based on the criteria identified in the NCP. The alternatives also are compared to each other in this section.
- Section 5, *References*: Lists the reports and references used during the preparation of this FFS report.

Appendixes present the conceptual designs of the various alternatives including estimated costs.

Definitions

Definitions that will be used throughout this document include the following.

LNAPL. Light nonaqueous phase liquid. LNAPL has a specific gravity less than 1.0.

Source Material. Material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, or to air, or act as a source for direct exposure (USEPA 1991).

Principal Threat Waste. Source material considered highly toxic or highly mobile that generally cannot be reliably contained and that would present a significant risk to human health or the environment should exposure occur (USEPA 1991). They include liquids and other highly mobile materials or materials having high concentrations of toxic compounds.

Low-Level Threat Waste. Source material that generally can be reliably contained and that would present only a low-level risk. They include source materials that exhibit low toxicity, low mobility in the environment, or are near health-based levels.

Site Background and History

The current Diamond Head property is inactive and consists of approximately 15 acres of undeveloped land located near the Hackensack Meadowlands in Kearny, New Jersey. Figure 1-1 shows the site location. The area surrounding the site is industrial; the nearest residential area is 0.5 mile to the west; there are no residential areas to the north, south, and east. Land use within 1,000 feet of the site consists of light industrial to the north, northwest, and west and wetlands (meadowlands) to the east, northeast, and south where the Municipal Sanitary Landfill Authority (MSLA) landfill is situated south of Interstate 280 (I-280).

The current property was part of a former oil-reprocessing facility(Diamond Head Oil Refining Company) that operated from February 1, 1946, to early 1979. During facility operations, multiple aboveground storage tanks (ASTs) and possibly below grade pits were used to store oily wastes. These wastes were intermittently discharged directly to adjacent properties to the east and the wetland area on the south side of the site, creating an oil lake. From the close of operations in 1979 until 1982, the abandoned site was not completely fenced. It was reported that during this time, oily wastes and other debris were dumped at the site (CH2M HILL 2005).

In 1968, the New Jersey Department of Transportation (NJDOT) acquired part of the Diamond Head Oil property for the construction of I-280 from the Phillips Screw Company (PSC), who in turn had acquired the property through an intermediate company, from the Diamond Head Oil Refining Company. In 1977, when beginning construction of I-280, NJDOT reportedly removed 10 million gallons of oil and oil-contaminated liquid and 230,000 cubic yards of oily sludge from the oil lagoon. NJDOT also reported that during the I-280 construction, an underground "lake" of oil-contaminated groundwater was found extending from the eastern limits of the I-280 right-of-way to Frank's Creek west of the site. During I-280 construction, the entire oil lagoon was apparently filled, as it no longer appears on post–I-280 construction aerial photographs from 1979. Aerial photographs from 1982 show that the reprocessing infrastructure of the site had also been dismantled.

The site was listed as a Superfund site on the National Priorities List (NPL) in September 2002. Figure 1-2 shows a site plan of the site.

During the preparation of this final FFS, new information became available on the history and contents of the earthen berms along the east and south borders of the current Diamond Head property. A brief summary follows.

As noted above, in preparation of constructing I-280, over 10 million gallons of oil and oil containing liquid were pumped from the lagoon and shipped to waste oil-recycling facilities outside of New Jersey.

The remaining oil-contaminated sludge was then excavated. For this purpose, a large depression was reportedly constructed on the MSLA-1-D landfill to the south of I-280. The depression was reportedly lined with clay before placing the waste in it; when filled, the area was capped with clay, top-soiled and seeded.

Since this initial space was not sufficient to dispose of all of the excavated sludge materials, two additional depressions were reportedly constructed on the opposite side of Route I-280 from the MSLA-1-D landfill. These depressions, apparent on aerial photographs from 1978, were located in the NJDOT right-of-way along Ramp M and Interstate I-280 Westbound. These two areas were to be lined with 6 inches of borrow excavation.

Additional disposal areas were required for the remaining sludge and a third area was identified for the disposal on an 11.6 acre site owned by the Township of Kearny. This site was reported to have been excavated to a depth of 12 to 14 feet and later covered in topsoil and seeded. Of note, the west parcel of the Diamond Head property where the landfill is situated, is 11.6 acres in size. An aerial photograph from 1976 shows the landfill covered with vegetation and no evidence of the construction of I-280 and the east and south berms. A subsequent aerial photograph from 1978 shows grading of the landfill area, the construction of I-280, and the appearance of mounds at the locations of the east and south berms (two of those mounds have the shape of elongated depressions). Finally, an aerial photograph from 1979 shows the berms in their current shape along with a large area of dark staining in the south berm, south of the location of SD-35 where the oil seep is currently noted in the drainage swale.

Upon completion of disposal, 90,693 cubic yards were recoded as being disposed of in the MSLA-1-D landfill, 46,535 cubic yards were recoded as being disposed of onsite (i.e., within the I-280 right of way), and 94,0731 cubic yards were recorded as being disposed of at the Town of Kearny site.

According to a letter to the Solid Waste Administration of the USEPA, the solid waste underlying the oil lake was described as soils, sanitary landfill, and industrial wastes-contaminated by oil. Cresent Construction Co, Inc. and Ell-Dorer Contracting Co. described the base of the lake as "filled with plastic containers, discarded car and truck tires" at the time of removal.

This new historic information became available at the time when the OU2 drilling activities were ongoing at the site. This allowed for the drill rig to be mobilized to the berms to obtain information on the contents of the berms and collect soil samples. Described below are the OU2 soil boring activities and associate sampling performed on the berms and the observations. The analytical data from the berms was not available at the time of preparation of this final FFS.

South Berm

During the OU2 sampling activities, four soil borings (SB-52 through 55) were installed through the top of the southern soil berm. The borings were advanced using direct push technology (DPT) to a depth of between 16-feet and 25-feet below ground surface (bgs). The initial soil boring (SB-52) was installed as close as possible to sediment sample location SWSD-35 where an oil seep was observed during the Phase 1 RI and more recently during the OU2 activities. This seep is from the toe of the berm into the adjacent drainage swale. Subsequent soil borings were advanced towards the east from this location along the crest of the berm, at an approximate 200-foot spacing (starting with SB-53 in the southwest, closest to the first location, and finishing with SB-55 in the northeast, furthest away from the first location) .

In general, the lithology at each location included a silty topsoil from 0 – 3 feet bgs which contained no indication of contamination. A dark gray silty clay layer with small intermittent layers of sandy fill, similar to soil observed onsite above the peat layer, is present from approximately 3 feet bgs to 22 feet bgs. In general, the silty clay material possess an organic odor and contains moderate to dense refuse comprised of mainly plastic and wood material similar to soil observed within the onsite landfill and within the I-280 cloverleafs. Two out of the four borings installed ontop of the southern berm were terminated at 16 feet and 18 feet bgs (that is, before penetrating the full thickness of the elevated berm) due to drilling refusal. Cement residue was observed on the tip of the drill rod.

Slight petroleum-like odors were observed in each boring within the south berm throughout most of the silty clay layer. Moderate oil-like odors were present generally within the 10 foot to 14 foot bgs interval and the 17 foot to 18 foot bgs interval. A strong gasoline like odor was observed in boring SB-52 boring from approximately 16 feet to 17 feet bgs. A slight oil-like sheen was observed in soil boring SB-52 from approximately 15 feet to 16 feet bgs and small oil seams were observed in SB-54 at 13.5' bgs, and in SB-55 at 21.5' bgs. PID detections occurred in each soil boring in the south berm within the silty clay layer at an average of 5 ppm. In specific intervals where oil odors or sheens were observed, elevated PID readings ranged from 7.7 ppm to 36 ppm. Soil observed in SB-52 potentially impacted with gasoline from 16-17 bgs had the highest PID reading at 85 ppm.

Soil samples were collected from all soil borings from depths that were impacted based on visual observations and PID readings. The samples were sent for analyses for full organics and inorganics through EPA's Contract Laboratory Program (CLP).

East Berm

Two soil borings (SB-56 and 57, SB-56 is the southern of the two borings) were installed within the east berm located along Ramp M. In general the lithology of these two borings was similar to soil borings installed in the southern berm with the exception of a 6-inch sand layer occurring at approximately 21.5 feet bgs. The sand layer appeared in distinct contrast to the materials above and below and could possibly represent the "borrow excavation material" which was reportedly installed to line the base of the soil berms.

Visual evidence of contamination in the eastern berm is similar in nature to but more pronounced than the southern berm. Moderate organic-like odors were present throughout the silty clay layer with strong oil-like odors occurring from approximately 7.5 feet – 22 feet bgs. Small intermittent oil seams were present from approximately 5.0 - 7.5 feet bgs, and again from 11 feet bgs through 16.5 feet bgs. Oil globules were observed in the groundwater-soil interface at the southern most soil boring (SB-56) within the east berm. PID readings averaged 35ppm throughout the silty clay layer and ranged from 16 ppm to 120 ppm in areas apparently impacted by oil.

Visual and PID results collected from soil borings during the OU2 sampling event suggest that the presence of contaminated materials within the eastern berm may be more significant than in the southern berm. However, significant oil seepage into the swale has been observed at the southern berm and is less apparent near the eastern berm. It is unclear at this point, however, if the source of this seepage is related to oil-containing materials within the berm or oil from the site that is undercutting the berm.

Soil samples were collected from all soil borings from depths that were impacted based on visual observations and PID readings. The samples were sent for analyses for full organics and inorganics through EPA's CLP.

In summary, the visual observations from this limited OU2 sampling event suggest that the onsite soil berms contain some LNAPL. The information, however, is not sufficient to determine whether the berms should be included under the remedial objectives of this early action. Due to the limited extent of this sampling program, additional investigation work would be needed to make this determination. This work can be performed as part of any pre-design investigations.

OU1 RI/FS Objectives

To date, USEPA Region 2 has completed two phases of remedial investigations at the site. The objective of the first phase of RI activities completed in 2003 was to gain an overall understanding of the chemical and LNAPL contamination found in the various media at the site. The Phase 1 RI results, presented in the Phase 1 technical memorandum (CH2M HILL 2005), identified significant LNAPL presence at the site. Based on these results, USEPA determined that LNAPL serves as source material that likely releases contamination to the various media at the site and should, therefore, be addressed through an Early Action. Based on this determination, USEPA Region 2 divided the site into two OUs with LNAPL being addressed as part of OU1. A focused OU1 RI (the Phase 2 RI for the site) was thus initiated in 2007 with the following objectives specific to the LNAPL source material:

1. Delineate and assess the mobility of LNAPL observed during the Phase 1 RI in the former lagoon area and former refinery area.
2. Collect information to support a focused feasibility evaluation of remedial alternatives appropriate for undertaking an Early Action for LNAPL.

The OU1 RI also targeted obtaining information on the contents of the landfill found at the site. The objectives were to look for visual indications suggesting that oily wastes / sludge may have been deposited in the landfill and confirm that, as suggested by the Phase 1 RI results, the landfill does not constitute a source to groundwater contamination.

The Phase 2 RI was completed in 2008 and its results presented in the *Phase 2 Focused Remedial Investigation Technical Memorandum* (CH2M HILL 2009).

Nature and Extent of LNAPL Source Material

The 1995 Phase 1 RI outlined two areas as potential source areas where LNAPL may be continuing to release contamination to the environment:

- Former oil-reprocessing section of the site—with two buildings, multiple ASTs, drum storage areas, and possibly underground pits
- Former oil lagoon—with an approximate area of 5 acres located over the southern section of the site and extending outside the site's physical property boundaries to the east and south

Currently, in the oil-processing section of the site, only the foundations of one building and two ASTs are visible. There are no physical demarcations at the site that can be used to establish the boundary of the former lagoon. Historical information suggests the lagoon occupied the southeastern section of the site and extended eastward beyond the current site property boundary. Figure 1-3 shows the boundary of the former lagoon compiled from historical aerials of the site. This figure also shows the locations of the Phase 1 RI points.

The Phase 1 RI (CH2M HILL 2005) concluded the following:

- There is evidence of oil contamination in all of the Phase 1 borings and in half of the borings installed during a 1999 investigation conducted by the property owner prior to the site's listing on the NPL.
- LNAPL is present in the southeastern corner of the site in the area of the former lagoon. The LNAPL covers an area of approximately 80,000 square feet (ft^2), is up to approximately 5 feet thick at some locations, and affects between 2,800 and 5,000 cubic yards of the vadose zone.

- LNAPL appears to contain more diesel range organics (DROs) than gasoline range organics (GROs). LNAPL contained benzene, toluene, ethylbenzene and xylenes as well as a number of semivolatile compounds and metals, including lead.

Figure 1-4 shows the locations of the focused Phase 2 RI points. The focused Phase 2 RI (CH2M HILL 2009) concluded the following on to the presence of LNAPL contamination at the site:

- LNAPL was measured in wells in two geographic areas of the site: the area around piezometers PZ-7 and PZ-10 and a second area between MW-13S and PZ-14. During the Phase 2 RI, LNAPL was also observed at PZ-16 but since no LNAPL was found in the surrounding piezometers, an area around this piezometer where LNAPL is present could not be drawn. While it was not measured in wells in other areas of the site, the laser induced fluorescence (LIF) study conducted at the site concluded that LNAPL is present in the subsurface throughout most of the investigated area.
- LNAPL is distributed from the water table (approximately 2 feet below ground surface [bgs]) through the saturated zone to depths of 16 feet bgs at some locations.
- The vertical occurrence of LNAPL can be further separated into two depth intervals: (1) at the water table and sometimes with an extended smear zone into the saturated fill-containing material and soil up to 9.5 feet bgs and (2) as a distinct deeper interval at depths of 10 to 16 feet bgs within the silty/clayey soil. The bulk of LNAPL-containing soil is located near the water table within the fill layer, but some also is present within the silty/clayey soil in the deeper stratigraphic zones.
- Despite the large thickness of LNAPL found in some monitoring wells and its relatively high saturation, LNAPL is extremely viscous and is relatively immobile under ambient gradients. The soil conductivity to LNAPL is very low (equivalent to less than 10^{-5} centimeters per second [cm/s] for water in soil), and the estimated seepage velocity of LNAPL was calculated to range from about 0.004 foot per year up to a maximum of only about 0.1 foot per year, suggesting limited LNAPL mobility. The relatively immobile LNAPL is self-contained and therefore poses relatively low risk of future lateral migration.
- Based on potential remediation-induced LNAPL gradient and recovery analysis, the LNAPL is deemed poorly recoverable with any fluid recovery-based remediation system. Simplified LNAPL recovery modeling indicated that over 30 years, only approximately 6 percent of the total in situ LNAPL volume could be recovered.
- Within the area where LNAPL is found, there are pockets of less weathered LNAPL of high saturation where it presents a leaching concern to groundwater. These are LNAPL areas that may be considered to present a risk for leaching contaminants to groundwater. LNAPL was tested using the synthetic precipitate leachate procedure (SPLP) to assess what compounds may present a leaching concern. The results have suggested some leaching potential for benzene and a couple of cresol isomers.
- LNAPL at the site was confirmed to contain more DROs than GROs. The following compounds or classes of compounds were detected in the LNAPL: benzene, toluene, ethylbenzene, and xylenes as well as a number of other volatile and semivolatile organic compounds (VOCs and SVOCs) consistent with a petroleum matrix; two polychlorinated biphenyls (PCBs) (Arochlor-1232 and Arochlor-1260); and a variety of metals, including lead and cyanide.

The focused Phase 2 RI (CH2M HILL 2009) concluded the following on the characteristics of the onsite landfill:

- The majority of the observed landfill contents consisted of municipal-type wastes with a lesser component of demolition-type debris. While staining and odors were noted during the trenching activities conducted in the landfill, there was no evidence that oily wastes and / or sludge from the lagoons were deposited in the landfill.
- Samples collected to characterize the landfill's contents indicated pervasive contamination with both organic and inorganic contaminants. In each sample, the concentrations for at least one class of compounds exceeded the NJDEP non-residential direct contact levels. As expected based on the heterogeneous nature of the landfill materials, no spatial or vertical trends in contamination could be noted from the characterization sampling.
- The classes of contaminants detected in the landfill samples were consistent with the classes of contaminants found in the surface and subsurface soils during the Phase 1 RI. And while some concentrations exceeded the NJDEP direct contact levels, the Phase 1 groundwater sampling results did not suggest that the landfill acts as a source to groundwater contamination. Groundwater sampling is planned to confirm the Phase 1 RI groundwater sampling results.

Principal Threat Evaluation

USEPA's *Guide to Principal Threat and Low Level Threat Wastes* (USEPA 1991) describes source material as "material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater, to surface waster, to air, or acts as a source for direct exposure." LNAPL is considered to represent the source material at the Diamond Head site.

The principles outlined in the NCP [(40 CFR 300.430(a)(1)(iii)] and the above USEPA guide were used to evaluate whether this source material represents a principal or a low level threat.

Specifically, principle threat wastes are defined as "those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. They include liquids or other highly mobile materials (e.g., solvents) or materials that have high concentrations of toxic compounds."

Low-level threat wastes are defined as "those materials that generally can be reliably contained and that would represent a low risk in the event of a release. They include materials that exhibit low toxicity, low mobility in the environment, or are near health-based levels."

The NCP and USEPA's *Guide to Principal Threat and Low Level Threat Wastes* (USEPA 2001) outline the following expectations for addressing principal and low-level threat wastes:

- Use "treatment to address the principal threats posed by a site, wherever practicable"

- Use "engineering controls, such as containment, for waste that poses a relatively low long-term threat"

The following lines of evidence based on site-specific data were used to evaluate whether the LNAPL source material at the Diamond Head site represents a principal and/or a low level threat:

- Review of the area of the site affected by LNAPL and the characteristics of the LNAPL source material as defined by the results of the LIF investigation and specialty soil sampling performed during the Phase 2 RI
- Assessment of the presence of LNAPL in the soil column through interpretation of individual LIF logs
- Areas where a measureable thickness of LNAPL was found in monitoring wells and piezometers during the Phase 1 and 2 RIs
- Areas where LNAPL was visually observed in the pore spaces of soil cores collected from Phase 1 RI soil borings

Based on these, the LNAPL source material is separated into two areas:

- The area where LNAPL material is considered to represent a principal threat and which is defined as the Remedial Target Area (RTA) for the remedial alternatives evaluated in this FFS
- The area where LNAPL can be considered to represent a low-level threat and for which appropriate measures will be considered during future feasibility studies

The areas where LNAPL is considered to represent a principal threat include the following:

- Geographic areas where measurable thickness of LNAPL was found in monitoring wells during the Phase 1 and 2 RIs
- Areas where LNAPL was determined to have the potential to leach contaminants to groundwater based on the Phase 2 RI results

There are two geographic areas of the site where monitoring wells contain measurable thicknesses of LNAPL (that is, greater than 0.01 foot thick). These areas are shaded in yellow on Figure 1-5. LNAPL found in these areas is considered to represent a principal threat. The total area affected is roughly 10,000 square feet.

Sampling of LNAPL performed during the Phase 1 and 2 RIs indicated that LNAPL contains a variety of chemical contaminants (VOCs, SVOCs, PCBs, and metals). The contaminants found in LNAPL also are found in other media at the site at concentrations above various standards and criteria – thus, suggesting that LNAPL acts as a source, releasing the contaminants that it contains into these media.

The focused Phase 2 RI defined the area of LNAPL where contaminants have the potential to leach to groundwater as the area where LNAPL presence resulted in greater than 40 percent Reference Emitter (% RE) response. Figure 1-5 shows the areas showing a greater than 40% RE response shaded in orange. The total area affected is roughly 115,000 square feet. LNAPL found in these areas is considered to represent a principal threat. It should be noted that there is an area with greater than 40% RE within

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the cloverleaf of I-280. Current and future exposures to the material in this area are likely to be limited because of the use of the area (cloverleaf of I-280); as such, this area is not included within the RTA for this Early Action.

Figure 1-6 included in this FFS from the Phase 1 RI technical memorandum (CH2M HILL 2005) shows contaminant concentrations in groundwater exceeding various standards and criteria during the Phase 1 RI. Figure 1-7 also included in this FFS from the same report shows total VOC and SVOC isoconcentration contours. As shown on both figures, the highest groundwater contamination is found within the general area of 40% RE, supporting the concern that contaminants in LNAPL in that area are mobile and have leached to the groundwater.

Finally, examination of individual LIF logs within this area shows that LNAPL presence begins at the ground surface where contact with LNAPL material is possible.

Outside the above areas, the LNAPL source material is considered to present a low-level threat based on its low mobility and leachability potential and will be addressed through future feasibility studies.

Assessment of Risks Associated with LNAPL Source Material

The focus of this early action is to address LNAPL that constitutes a principal threat at the site. The principal-threat LNAPL is physically similar to free oil product. Oil products are toxic to ecological receptors and humans through direct contact, incidental ingestion, and inhalation pathways. Potential exposure to ecological receptors and humans from the high-concentration LNAPL that is present at the site could result in adverse health effects. It is, therefore, important that steps be taken to reduce or eliminate the volume of LNAPL present at the site. Reducing or eliminating the LNAPL at the site would reduce potential exposure to free product and it is an important early step in managing risk at the site; however, it is not expected to eliminate the overall risks and hazards to ecological receptors or humans because of residual contamination that would remain on the site. This residual contamination will be addressed in subsequent actions and will be accompanied by full ecological and human health risk assessments.

In addition to removing the potential exposure to LNAPL at the site, reducing or eliminating the LNAPL at the site would also limit the potential migration of LNAPL, which would aid in investigating and selecting a remedy for the remainder of the site.

SECTION 2

Development and Identification of RAOs, PRGs, and ARARs

Introduction

This section presents general and site-specific RAOs, identifies corresponding ARARs and "to be considered" (TBC) requirements, and discusses the PRGs developed to meet the RAOs for the principal threat waste identified at the site.

General RAOs are defined by the NCP and CERCLA (as amended by the Superfund Amendments and Reauthorization Act [SARA]) and apply to all Superfund sites. CERCLA defines the statutory requirements for developing remedies.

Site-specific RAOs relate to specific contaminated media and potential exposure routes identified to be of concern at a site. The RAOs identify target remedial goals for these media and exposure pathways. Site-specific objectives are set based on an understanding of the contaminants and the physical properties of the media in which these contaminants are found at a site. PRGs are developed to achieve the RAOs established for the site.

This section is comprised of the following subsections:

- Introduction
- NCP and CERCLA objectives
- Development of site-specific RAOs
- PRGs
- RTA and volume of principal threat LNAPL source material
- Applicable or relevant and appropriate requirements

NCP and CERCLA Objectives

The NCP requires that the selected remedy meets the following objectives:

- Each remedial action selected shall be protective of human health and the environment [40 CFR 300.430 (f)(ii)(A)].
- Onsite remedial actions that are selected must attain those ARARs that are identified at the time of the ROD signature [40 CFR 300.430(f)(ii)(B)].
- Each remedial action selected shall be cost-effective. A remedy shall be cost-effective if its costs are proportional to its overall effectiveness [40 CFR 300.430 (f)(ii)(D)].
- Each remedial action shall use permanent solutions and alternative treatment technologies or resource-recovery technology to the maximum extent practicable [40 CFR 300.430 (f)(ii)(E)].

The statutory scope of CERCLA was amended by SARA to include the following general remedial action objectives at all CERCLA sites:

- Remedial actions "shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further releases at a minimum which assures protection of human health and the environment" [Section 121(d)].
- Remedial actions "in which treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element" [Section 121(b)] are preferred. If the treatment or recovery technologies selected are not a permanent solution, an explanation must be published.
- The least-favored remedial actions are those that include "offsite transport and disposal of hazardous substances or contaminated materials without treatment where practicable treatment technologies are available" [Section 121(b)].
- The selected remedy must comply with or attain the level of any "standard, requirement, criteria, or limitation under any Federal environmental law . . . or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility citing law that is more stringent than any Federal standard, requirement, criteria, or limitation" [Section 121(d)(2)(A)].

Development of Site-Specific RAOs

Site-specific RAOs are established based on the nature and extent of the contamination, the receptors that are currently and potentially threatened, and the potential for human and environmental exposure. Both the level of contamination and the potential exposure pathway are important considerations in developing RAOs at a site. For example, protection at a site can be achieved by both lowering the contaminant levels and by reducing the potential for exposure through a particular exposure route.

PRGs are site-specific goals that define the extent of cleanup required to achieve the RAOs. The PRGs are developed during the FFS, and are finalized in the ROD for the site.

The following three requirements in New Jersey Administrative Code (NJAC) 7:26E-1.13(b)2(v) and NJAC 7:26E-6.1(d) were considered in developing the RAOs for the Early Action for addressing LNAPL identified to represent a principal threat at the Diamond Head site:

- Removal or treatment of recoverable LNAPL where practicable
- Containment of potentially mobile LNAPL where removal is not practicable
- Treatment of residual LNAPL where practicable

Based on the above considerations, the following RAOs were developed:

- Remove, treat, or contain the principal threat LNAPL pursuant to NJAC 7:26E-1.13(b)2(v) and NJAC 7:26E-6.1(d)
- Prevent current and future migration of LNAPL and chemical contaminants from the principal threat LNAPL to the various media at the site including preventing future

seeps to the drainage swale where a seep of LNAPL was observed during the Phase 1 RI activities

- Prevent human exposure to the principal threat LNAPL

The first two RAOs are intended to address the principal threat LNAPL and the contamination that may be released from this material. The third RAO is intended to address risks to potential future site workers / users as a result of exposures to this material.

Specifically, although LNAPL was determined to be highly viscous and is immobile, it contains a variety of chemical contaminants. Direct exposure to accessible principal threat LNAPL source material through direct contact, ingestion, or inhalation would be limited to site trespassers under existing conditions, as the site is currently unoccupied and fenced. However, under current conditions, the chemical contaminants in LNAPL would continue to leach from the material to groundwater, thus contaminating this media. Surface water and sediment in the drainage swale along the eastern and southern property borders may receive contamination as a result of groundwater discharge to the swale as well as through direct seeps of LNAPL to the swale. One such seep was noted along the drainage swale during the Phase 1 RI. Surface water and sediment at this location were sampled (location SWSD-35 on Figure 1-3). The location is immediately south of the RTA boundary. The remedial action for the principal threat LNAPL material should prevent future seeps into the drainage swale.

Future redevelopment of the site may result in direct exposures to the principal threat LNAPL by site construction workers as well as future site users. Vapor intrusion of volatile contaminants originating from the principal threat LNAPL to future buildings at the site may also present concerns.

The RAOs identified above are focused on addressing the LNAPL mass and do not specifically address the co-located chemical contamination in soil at the site. Some of this chemical contamination is likely associated with LNAPL. Therefore, in reducing the mass of LNAPL, the Early Action also will likely reduce some of the co-located chemical contamination and as a result, the unacceptable risks to potential human and ecological receptors associated with both the LNAPL and co-located chemical contamination at the site.

Better understanding of the degree to which the reductions of both LNAPL and co-located chemical contamination occur following the implementation of the Early Action is important. Treatability testing of the selected treatment technologies is recommended in order to evaluate their effectiveness for removing LNAPL as well as evaluate their effect on the co-located chemical contamination. The results can be used to optimize technology performance and support achieving future RAOs established for the entire site – thus leading to overall cost savings. While the effects of the selected technologies on the co-located chemical contamination cannot be quantified at the time of preparation of this FFS, the effectiveness of each alternative is presented in terms of LNAPL source reduction and the technology's potential to reduce concentrations of other chemicals present at the site.

Following completion of the Early Action, additional investigations are expected to be needed to determine the concentration and risk posed by the remaining chemical contamination at the site. The overall site remedial action would then focus on addressing this residual chemical contamination. It is, therefore, important that the technology selected for LNAPL treatment does not interfere with future investigations or remedial actions that may be needed for the remaining chemical contamination at the site. This also is considered in the assessment of technologies presented in this FFS.

Preliminary Remedial Goals

PRGs are site-specific goals that define the extent of cleanup required to achieve the RAOs. The PRGs for LNAPL were developed considering the available chemical-specific ARARs or TBCs requirements, including applicable New Jersey remediation standards and criteria.

There are no numeric ARARs for LNAPL in soil. Therefore, a PRG was defined based on the criteria used to identify the LNAPL source material that represents a principal threat: measurable thickness of LNAPL in monitoring wells and the potential for the LNAPL to leach the contaminants that it contains to groundwater.

Specifically, the PRG to be achieved following implementation of this Early Action is as follows:

- No measurable thickness of LNAPL in monitoring wells

Progress of the treatment technologies toward achieving the PRG would be assessed under all alternatives involving treatment. One approach for measuring progress, for example, may include collecting samples of treated LNAPL-containing soil and extracting the samples using SPLP to assess what remains in the treated matrix that can leach to groundwater. The SPLP is expected to provide a conservative estimate of what may leach to groundwater as it involves aggressive extraction by agitating the sample with pH 4.2 water for 18 hours. The SPLP extract can be analyzed for oil and grease to assess how much LNAPL remains in the treated matrix as well as for various chemical constituents to assess their leaching to groundwater. An indication of no oil and grease in the SPLP extract would be considered an indication that the established PRG may have been reached – that is, indicating that measureable thickness of LNAPL will likely not occur in monitoring wells within the treated area. Compliance monitoring wells installed within the RTA would then be observed to confirm this.

Chemical concentrations in the SPLP extract would provide an indication on potential contaminant concentrations in groundwater following treatment relative to the New Jersey Class IIA groundwater quality standards and other numeric, chemical-specific ARARs for groundwater. While addressing contaminated groundwater is not part of this Early Action, the results of these analyses would provide useful information in support of future considerations for addressing groundwater. Of note, chemical constituents found in the SPLP extract from a treated LNAPL-containing soil sample would reflect both chemical contaminants released from the LNAPL as well as co-located chemical contamination in the soil matrix.

The specific tests and analyses to be performed to assess the progress of the selected treatment technology toward achieving the PRG will be determined as part of the remedial design.

It should be noted that while the alternatives involving treatment evaluated in this FFS are expected to achieve the established PRG, they will leave varying amounts of LNAPL within the RTA; the alternatives identified and included in this FFS (except for excavation and offsite disposal) are not expected to completely remove all LNAPL from the site and treat all the co-located chemical contamination. The practicable degree of LNAPL reduction to be achieved by each treatment alternative will be empirically determined during treatability testing at the start of the remedial design and will likely be refined during the process of Early Action implementation. This may include using an observational approach based on actual system operations and monitoring data as well as through treatability testing before implementing the full-scale alternative. System operation will continue, with optimization and modifications made to maximize effectiveness, until a point of diminishing returns occurs where additional operation is not expected to appreciably improve site conditions.

It also should be noted that following the implementation of this Early Action, additional technologies may provide further removal (beyond the PRG established in this FFS) of LNAPL. Because without treatability testing, the degree of LNAPL mass removal that can be accomplished by a single technology cannot be predicted, this FFS is conducted for developing a single Early Action for LNAPL treatment. Further treatment and polishing for LNAPL beyond the PRG established in this FFS, if desired following this Early Action, can be achieved during implementation of the overall remedy selected for the site.

Remedial Target Area and Volume of LNAPL Source Material Requiring Remedial Action

The horizontal extent of the RTA for the purposes of developing remedial alternatives and estimating associated costs in this FFS is shown with the red boundary line on Figure 2-1. This horizontal extent encompasses areas where measurable thickness of LNAPL is found in wells (shown in yellow in the figure) and areas with greater than 40% RE (shown in orange in the figure) where LNAPL has the potential to leach contaminants to groundwater. It should be noted that the boundary of the RTA in Figure 2-1 was drawn to account for the following uncertainties – lack of data points in some areas and the inherent uncertainty associated with use of mathematical modeling to estimate the extent of the areas where leaching may occur.

A pre-design investigation will be needed to refine the boundaries of this RTA (horizontal and vertical) and assess whether the berms should be included within the RTA or whether their contents does not constitute a principal threat.

Specifically, the outlines of the orange areas in Figure 2-1 where contaminants may leach from LNAPL to groundwater are based on actual data as well as mathematical kriging (interpolation of the actual highly discrete LIF data). In addition, during the Phase 2 RI, LNAPL was found in PZ-16 but not in surrounding wells; as a result, it is uncertain if there is a third, smaller geographic area of the site, where LNAPL is found in wells. A supplemental investigation would be needed to identify the actual boundaries of the various areas that need to be included in the RTA and thus, limit the uncertainties associated with the RTA boundaries.

During the Phase 2 RI, LNAPL was found to occur at two depth intervals: (1) at the water table and sometimes with an extended smear zone into the saturated fill-containing material and soil up to 9.5 feet bgs and (2) as a distinct deeper interval at depths of 10 to 15 feet bgs within the silty/clayey soil. The highest concentrations of LNAPL were located near the water table within the fill layer. Within the silty/clayey layer, LNAPL was found only in the upper 6 inches, and only approximately 494 cubic yards of soil were found to be impacted based on the 40% RE or more criteria. This represents about 12 percent of the total 40% RE-impacted soil volume of 4,276 cubic yards at the site, suggesting LNAPL contamination in this silty/clayey layer within the RTA may be relatively isolated.

The thickness of the silty/clayey layer ranges from 2 to 8 feet and is continuous within the physical boundaries of the site. This layer represents an important site condition that is believed to serve as a competent natural barrier to the vertical migration of contaminants into the underlying unconsolidated estuarine sediments. This is supported by the contaminant concentrations measured during the Phase 1 RI in groundwater beneath this silty/clayey layer and the underlying peat layer (these concentrations were significantly lower than those measured in shallow groundwater above these layers).

Therefore, this FFS defines the remedial target depth to extend up to the top of the silty/clayey layer within the RTA. The pre-design investigation would include work elements to identify the depth to the top of this layer across the RTA so that remedial activities do not compromise this important natural barrier to vertical contaminant migration.

Based on currently available data, within the RTA, the depth to the top of this layer varies between 6 and 12 feet bgs, with the most common depth at 7 feet. Therefore, an average depth of 7 feet bgs is used to estimate the volumes of media for this Early Action.

Following the pre-design investigation and better definition of the target area (horizontal and vertical), some adjustment will likely need to be made to allow for ease of constructability of the selected alternative. It is expected that the RTA limits following the pre-design investigation will be refined and that the overall RTA will be smaller (potentially comprised of several smaller RTAs) than the general RTA presented in this FFS report.

Based on the assumptions used in this FFS, the RTA areas and volumes for this Early Action are summarized below.

Area	Area (SF)	Volume (CY)
Northern Triangle-Shaped Area	25,074	6,501
Southern Trapezoid-Like Shaped Area	151,677	39,324
Total	176,751	45,825

Additionally, within the southern trapezoid-like shaped area, the volume of the two areas shown in yellow on Figure 2-1 where LNAPL is observed in groundwater monitoring wells was estimated at 2,593 cubic yards.

Summary of Applicable or Relevant and Appropriate Requirements

Remedial actions must be protective of public health and the environment. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements, as well as to adequately protect public health and the environment.

Definitions of the ARARs and the TBC criteria are given below:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, environmental action, location, or other circumstance at a CERCLA site.
- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, which while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at a CERCLA site, that their use is well suited (appropriate) to the particular site.
- TBC criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing an interim remedial action, or are necessary for evaluating what is protective to human health and/or the environment. Examples of TBC criteria include the NJDEP Impact to Groundwater Soil Cleanup Criteria (IGWSCC), as well as the USEPA drinking water health advisories, reference doses, and cancer slope factors.

Another factor in determining which requirements must be addressed is whether the requirement is substantive or administrative. "Onsite" CERCLA response actions must comply with the substantive requirements but not with the administrative requirements of environmental laws and regulations as specified in the NCP, 40 CFR 300.5, definitions of ARARs and as discussed in 55 *Federal Register* (FR) 8756. Substantive requirements are those pertaining directly to actions or conditions in the environment. Administrative requirements are mechanisms that facilitate the implementation of the substantive requirements of an environmental law or regulation. In general, administrative requirements prescribe methods and procedures (for example, fees, permitting, inspection, reporting requirements, etc.) by which substantive requirements are made effective for the purposes of a particular environmental or public health program.

ARARs are grouped into three types: chemical-specific, location-specific, and action-specific. Included in Tables 2-1 through 2-3 are the chemical-specific, action-specific, and location-specific ARARs (including TBCs) that may apply to actions at a site. In these tables, highlighted in blue are the requirements which were determined to specifically apply to the remedial action alternative developed for the Early Action planned for LNAPL identified to represent a principal threat at the site.

Chemical-Specific ARARs

Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge. Table 2-1 lists the chemical-specific ARARs identified for the Early Action.

The ARARs for LNAPL at the site are the following New Jersey requirements for free-phase and residual LNAPL in NJAC 7:26E-1.13(b)2(v) and NJAC 7:26E-6.1(d):

- Removal or treatment of recoverable LNAPL where practicable

- Treatment of residual LNAPL where practicable
- Containment of LNAPL where removal or treatment are not practicable

As previously noted, the objective of the Phase 2 RI was the LNAPL source material (mobile and residual) rather than the sorbed chemical contamination in soil or chemical contamination in groundwater at the site. Additional investigations and feasibility evaluations are planned to address this chemical contamination. For chemical contamination at the site, the New Jersey soil cleanup standards and criteria and the groundwater quality standards would constitute ARARs (or TBCs as appropriate).

The Resource Conservation and Recovery Act (RCRA) land disposal restrictions (LDRs) would apply to remedial actions performed at the site if waste generated by the remedial action (such as contaminated soil) contains an RCRA hazardous waste. Listed hazardous wastes as defined by RCRA regulation are not known to have been released at the site. As a result, excavated soil would not be required to be managed as listed hazardous wastes.

If excavated and removed from the area of contamination (that is, the soil is "generated"), the soil may be a characteristic hazardous waste. Generated soil that exceed the toxicity characteristic leaching procedure (TCLP) limit must be managed as a hazardous waste and must meet the LDR treatment standards for contaminated soil (40 CFR 268.49). The treatment standard for contaminated soil is the higher value of a 90 percent reduction in constituent concentrations or 10 times the Universal Treatment Standards (UTS). Treatment is required for the constituent for which the soil is a characteristic hazardous waste as well as other "underlying hazardous constituents". Generators of contaminated soil can apply reasonable knowledge of the likely contaminants present to select constituents for monitoring (USEPA 1998).

Depending on the selected remedial technology, wastes that may be generated include recovered LNAPL, excavated soil containing LNAPL and other constituents, granular activated carbon that may be used to capture vapor emissions, recovered groundwater, and leachate from the different treatment units. Free-phase LNAPL and soil containing LNAPL have been sampled during both the Phase 1 and 2 RIs using the TCLP, in order to determine requirements for disposal. The results have been below the regulatory limits for characteristic hazardous waste. The results from groundwater samples also suggest that groundwater is not a characteristic hazardous waste. Therefore, this FFS assumes that similar wastes generated during the Early Action will continue to be classified as nonhazardous for disposal purposes. Because the quantity of the waste that would be generated from a remedial action would be significant, it is expected however, that additional waste characterization (either in situ or ex situ) would be required by the disposal facility accepting the wastes and will be performed as part of the pre-design investigation.

For water and air emissions generated during remedial actions, specific discharge and emission requirements would need to be met. These are discussed below under the action-specific ARARs.

Action-Specific ARARs

Action-specific ARARs regulate the specific type of action or technology under consideration, or the management of regulated materials. Table 2-2 lists the action-specific ARARs identified for the Early Action.

All but the No Action Alternative would require managing groundwater generated during implementation of the Early Action. Discharge to a publicly owned treatment works (POTW) was selected as the representative process option for managing the generated groundwater. Discharge of groundwater to the Passaic Valley Sewerage Commission (PVSC) treatment plant was considered in this FFS.

Discharge can be via a connection sewer or by trucking to PVSC. The nearest sewer line where the connection can be made was identified at the intersection of Bergen Avenue and Harrison Avenue. This sewer line is operated by the Kearny Municipal Authority (MUA) and is expected to be activated later this year.

A permit would need to be obtained for the connection to the MUA sewer and for discharge to the PVSC treatment plant. The permit would specify the requirements for discharging to the PVSC treatment plant.

PVSC has discharge limits for metals and oil and grease (average of less than 100 milligrams per liter [mg/L] or maximum of 150 mg/L). The metals concentrations in groundwater at the site are below PVSC limits. There is no data for oil and grease in groundwater at the site; therefore, this FFS assumes that some form of treatment would be needed to achieve the discharge limits for oil and grease. The pre-design investigation would need to obtain data on oil and grease at the site, and the design would determine the need for and actual type of treatment to meet discharge limits.

It is assumed that treatment of the discharge for VOCs and other contaminants will not be required and that the permit will only establish monitoring requirements. This FFS assumes that monthly monitoring and reporting will be required during the implementation period.

Discharge of treated groundwater through re-injection above the peat is considered impractical because of the shallow groundwater table. Discharge to surface water would require significant treatment to meet the limits for discharge to surface water. Construction of such treatment system would likely be un-economical and therefore was not included in this FFS.

Another important action-specific requirement relates to air emissions during implementation of an Early Action.

NJAC 7:27- 8 establishes permit conditions for minor facilities. The air emissions thresholds below which there are no permitting and air emission controls requirements are identified in NJAC 7:27-8, Tables A and B.

NJAC 7:27-22 establishes permit conditions for major facilities. Emissions from the Early Action are expected to be below these thresholds although confirmatory calculations will be performed during the design phase.

If emissions exceed the established reporting thresholds for minor facilities, then the operation of the alternative must be permitted under NJAC 7:27-8. If the emissions further exceed the established state-of-the-art (SOTA) threshold values, then emission controls would be required.

To determine if an air permit and emissions controls are required for each remedial alternative, the maximum potential emissions must be estimated and compared to the total and individual contaminants thresholds (reporting and SOTA) in Tables A and B. If the emissions are below the reporting thresholds, then a Request for Determination containing the estimated emissions would be submitted to NJDEP to confirm that a permit is not required. If emissions are above the reporting thresholds, then a permit application must be submitted, and the permit would establish the monitoring requirements as well as needed emission controls for emissions greater than the SOTA thresholds.

Of note, combustion equipment less than 1 million British thermal units (MM Btu) is not required to be permitted but must be noted in the Request for Determination. For equipment greater than or equal to 1 MM Btu, the emissions must be estimated and included in the air permit application, which will specify administrative as well as emission controls for emissions above the SOTA thresholds.

Also of note, emissions during excavation and from the soil washing operation must be estimated and included in the Request of Determination if found to be below the reporting thresholds or in the permit application if estimated to be above these thresholds.

The air pollution control regulations do not include specific monitoring requirements; these are typically established as part of a permit. For this site, while a permit may not be issued, the monitoring requirements specific to the site would be established by NJDEP following submittal of relevant information. It is reasonable to expect that monitoring frequency will be related to the total emissions from the Early Action and how close they are to the reporting thresholds.

During the pilot test for air sparging conducted during the focused Phase 2 RI, it was determined that emissions from the test were below the reporting thresholds. During the remedial action implementation, emissions may come from operating the biocell (injection of air to maintain aerobic conditions may result in emissions through vents) and during the excavation and management of soil. Calculations were performed to estimate the emissions from the biocell as well as during the excavation of soil.

Analytical soil results collected during the Phase 1 investigation were used to estimate an average concentration for detected VOCs. The average concentration was calculated based on detected VOC concentrations within the vertical and horizontal limits of the RTA. The partitioning calculations performed using these average concentrations suggest that VOC emissions from the biocell operation and during excavation activities would be below the NJDEP reporting thresholds with the exception of the emissions of 1,1-dichloroethylene and vinyl chloride. The partitioning calculations suggest that all VOC emissions would be below NJDEP SOTA levels and as such may not require emissions controls but will require monitoring. This will be verified during the remedial design when emissions will be estimated for the final RTA footprint and the request for determination or a permit application (as applicable) would be prepared and submitted to NJDEP. This FFS assumes that emissions controls would not be required (including for emissions from combustion equipment operated at the site). This will be confirmed during the design before a decision is made on whether air emissions controls are needed.

Other important action-specific ARARs that may affect the development of remedial action alternatives are the requirements under RCRA. RCRA regulations governing the identification, management, treatment, storage, and disposal of solid and hazardous waste would be ARARs for alternatives that generate waste that would be moved to a location outside of the area of contamination. Such alternatives could include excavation of impacted soil for offsite disposal. Requirements include waste accumulation, record keeping, container storage, disposal, manifesting, transportation, and disposal. If generated soil is a characteristic hazardous waste, RCRA LDRs would apply and treatment would be required in accordance with RCRA prior to disposal. This includes treatment of other underlying hazardous constituents as required by 40 CFR 268.9(a). This FFS assumes that all wastes generated from the Early Action would be nonhazardous.

Location-Specific ARARs

Location-specific ARARs are requirements that relate to the geographical position of the site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific ARARs. Early plans for redeveloping the site suggest the wetland area may be included into the redevelopment footprint and that the developer would replace this area at another location in accordance with applicable regulatory requirements. Based on this, the location-specific ARARs for the Early Action do not include considerations for wetlands restoration following Early Action implementation.

SECTION 3

Identification, Screening, and Evaluation of Remedial Technologies

Introduction

This section discusses the general response actions (GRAs) developed to meet the RAOs outlined in Section 2 for the LNAPL source material identified to represent a principal threat at the Diamond Head site. Identifying GRAs is the first step in the FFS alternatives analysis process; the GRAs are the basic actions that might be undertaken to remediate the principal threat LNAPL at the site. For each GRA, remedial technologies that may apply to the LNAPL source material were then identified. Under each remedial technology, there can be further a number of applicable process options; these also were identified. The remedial technologies and process options thus identified then underwent screening and evaluation to determine their suitability for incorporation into remedial action alternatives. Those technologies and process options that remained following the screening and evaluation were then assembled into remedial alternatives that each are based on one primary technology/process option for addressing the principal threat LNAPL at the site.

This section presents the GRAs, the remedial technologies and specific process options that could be implemented to address each GRA, the screening and evaluation results for the remedial technologies and process options, and the remedial alternatives assembled with the technologies and process options that remained following screening and evaluation.

This section is comprised of the following subsections:

- Introduction
- GRAs
- Screening and evaluation criteria for selecting remedial technologies and process options
- Screening and evaluation results
- Development of remedial action alternatives

The Phase 2 RI collected information to support the evaluation of remedial technologies in this FFS. Specifically, the Phase 2 RI activities included performing the following pilot tests of two remedial technologies typically used in LNAPL remediation: 1) LNAPL recoverability test to assess whether mobile LNAPL can be recovered using active or passive recovery methods, and 2) air/bio sparge test to assess whether air sparging could treat residual LNAPL by stimulating bacteria growth and activity.

The LNAPL recoverability pilot test concluded that LNAPL recovery is not feasible at this site. Specifically, the LNAPL at the site was found to be extremely viscous and relatively immobile under ambient gradients. Based on the tested remediation-induced LNAPL gradient and the performed recovery analysis, the LNAPL was determined to be poorly recoverable with any fluid recovery-based remediation system. For example, the simplified LNAPL recovery modeling indicated that over 30 years, only approximately 5 to 6 percent of the total in situ LNAPL volume could be recovered. Based on these results, LNAPL recovery technologies typically expected to be considered at sites with LNAPL, were not retained for this site following technology screening and evaluation.

The air sparging technology is not expected to be effective in removing the significant quantities of viscous LNAPL found at this site. However, the air sparging technology was determined to be effective in creating and maintaining aerobic conditions in the subsurface favorable to bacterial activity. Specifically, biological indicators monitored during the air/bio sparge test suggested that the aerobic conditions created by the test resulted in increases in biomass, changes in the bacterial community structure to more aerobic bacteria, and creation of a generally more favorable environment for the bacteria present in the subsurface. Based on these results, the air sparging technology typically expected to be considered at sites with LNAPL, was not retained for the removal of the LNAPL through sparging but for creating and supporting favorable conditions for biological activity leading to the treatment of LANPL.

A more detailed discussion of the results of the two performed pilot tests can be found in the final Phase 2 RI technical memorandum t(CH2M HILL 2009).

General Response Actions

GRAs are actions that might be undertaken to satisfy the RAOs for a site. After the RAOs and PRG were developed for the LNAPL Early Action, GRAs capable of meeting these objectives were identified. The No Action Alternative response also is included as it is required by the NCP as a baseline alternative against which all action alternatives are compared.

The GRAs for LNAPL are presented below along with an overview of what each GRA would entail.

General Response Action	Evaluation
No Action	Required by the NCP for comparison to other actions.
Monitoring	Used in conjunction with other GRAs to monitor effectiveness.
Institutional Controls	Reduces the likelihood of exposure to the LNAPL (direct contact, ingestion, or inhalation). Used in conjunction with other GRAs to address long-term site management,
Monitored Natural Attenuation	Reduces LNAPL mobility, toxicity, and volume through natural physical, chemical, and biological processes. The main processes include dissolution, biodegradation, and volatilization.
Containment	Minimizes exposure to LNAPL by confining and reducing its mobility.
In Situ Treatment	Reduces mobility, toxicity, and volume of LNAPL through in-place treatment using chemical, physical, or biological treatment processes.
Fluid Collection, Treatment, Discharge, and Disposal	Involves removal of LNAPL from the ground via fluid pumping. Therefore, collection reduces the volume of LNAPL. While under ambient conditions, the LNAPL is not mobile and may not be readily recoverable, some In Situ technologies may change the LNAPL characteristics so that it is more readily recoverable. It also includes collecting the water recovered during dewatering of excavations. The recovered

General Response Action	Evaluation
	water would need to be treated and the treated effluent may be discharged to surface water, groundwater, or a sewer system. The recovered LNAPL will need to be removed from the site for treatment and disposal.
Vapor Treatment and Discharge	Includes the treatment of air emissions from the implementation of the various technologies before their discharge to ambient air.
Soil Excavation, Treatment, and Disposal	Reduces volume of LNAPL-contaminated media via excavation and treatment / or removal from the site. Some dewatering would likely be required during excavation and the water would need to be treated and disposed as discussed above for Fluid Collection. Treatment of the excavated material may be done onsite and the treated material used as backfill. Or the material may be transported for offsite disposal.

Screening and Evaluation Criteria for Selecting Remedial Technologies

The technology types and process options available for addressing the principal threat LNAPL were screened and evaluated using the two-step process described below.

First, screening of technology methods began with the development of an inventory of technology types and process options based on professional experience, published sources, computer databases, and other available documentation for the GRAs identified above. Each technology type and process option included was either a demonstrated, proven process or a potential process that has undergone laboratory trials or bench-scale testing. The technology types and process options were then screened based on technical implementability. The following factors were considered in this evaluation:

- State of technology development
- Site conditions
- LNAPL characteristics
- Nature and extent of LNAPL contamination
- Other factors that could affect the effectiveness of the technology

The technology types and process options that were retained after initial screening under each of the GRAs were then evaluated based on the criteria of implementability, effectiveness, and cost. These criteria are described below:

- **Implementability** — "Implementability" refers to the relative degree of difficulty anticipated in implementing a particular technology/process option under regulatory, technical, and schedule constraints posed at the site. Implementability is evaluated in terms of both the technical and administrative feasibility of constructing, operating, and maintaining the technology/process option. Technical feasibility refers to the ability to construct, reliably operate, and comply with regulatory requirements during implementation of the technology/process option. Technical feasibility also refers to the future operation, maintenance, and monitoring after the technology/process option has been completed and the ability to implement the technology/process option consistent with proposed future land use standards. Administrative feasibility refers to the ability to obtain approvals and permits from regulatory agencies; the availability and capacity of treatment, storage, and disposal services; and the requirements for and availability of specialized equipment and technicians.

- **Effectiveness** — The effectiveness of a technology/process option was evaluated based on its ability to meet the RAOs under the conditions and limitations present at the site. The NCP defines effectiveness as the "degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risk, affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection." The key aspect considered in this FFS was the effectiveness of each technology/process option in treating the principal threat LNAPL at the site. If considered to be effective, consideration also was given to the effectiveness of the technology/process option in treating co-located chemical contamination.
- **Cost** — The primary purpose of the cost screening criterion is to allow for a comparison of rough costs associated with the technologies/process options. The cost criterion addresses costs of construction and long-term costs to operate and maintain technologies/process options that are part of an alternative. At this point, the cost criterion was qualitative and used for rough comparative purposes only; the costs were described comparatively as 'low', 'moderate', and 'high', with the 'high' qualifier indicating a high cost.

Site-specific considerations supporting the technology/process option ratings for implementability, effectiveness, and cost are described below.

Technologies/process options which provided the following were given higher rating:

- Ability to treat LNAPL and chemical contaminants of potential concern (COPCs) identified during the Phase 1 RI conducted at the site (which may be within the LNAPL matrix or adsorbed onto the soil)
- Minimal impact to future remediation and site redevelopment activities
- Minimal environmental impact during remedy implementation (that is, considering sustainability criteria such as green house gas emissions and non-renewable energy consumption)
- Potential to be effective in extremely heterogeneous lithologic setting

Technologies/process options that were determined to potentially interfere with future remedial investigations or future full-scale remedial measures for soil or groundwater were screened from further consideration. For instance, technologies such as in situ solidification/stabilization with cement additive would potentially interfere with future investigations or remedial measures and were therefore screened from further consideration.

Screening and Evaluation Results

Table 3-1 presents the technologies/process options that were retained after initial screening and the results of their evaluation relative to the three criteria of implementability, effectiveness, and cost. In Table 3-1, the technologies/process options that are not considered feasible after screening are shown in italicized text in the table. Technologies/process options retained after screening are bolded. Screening comments also are provided for each technology/process option. Based on the evaluation provided in Table 3-1, the following technologies/process options were retained under each GRA for further consideration in assembling remedial alternatives:

- **No Action** – Retained to meet the requirements of the NCP. No remedial technologies are implemented with this option.
- **Monitoring** – Retained to monitor the effectiveness of the chosen remedial action over the course of time. This may include monitoring LNAPL and groundwater concentrations and water and LNAPL levels in wells during implementation.
- **Containment** – Passive hydraulic controls, including slurry or sheet pile wall, were retained to provide a physical barrier to groundwater migration if excavation and dewatering are required and to isolate the treated area to prevent its recontamination as a result of migration of contamination from untreated areas.
- **In Situ Treatment** – The technologies/process options retained for the in situ treatment of LNAPL include the following:
  - Enhanced bioremediation – This technology involves degradation of contaminants through aerobic or anaerobic processes by stimulating biological growth through addition of an organic substrate and/or nutrients.
  - Biosparging – This technology involves biologic degradation of organics through stimulation of aerobic organisms by the addition of oxygen. It is typically conducted using low air flow rates so there is no need for vapor capture.
- **Fluid Collection, Treatment, Discharge (Treated Water), and Disposal (LNAPL)** – The technologies/process options retained for the treatment of water from dewatering during excavation and construction activities include the following:
  - *Fluids Treatment* – Treatment would be needed for any water extracted during dewatering. Treatment technologies for extracted water would depend on the contamination in the water (LNAPL as well as chemical contaminants) and the requirements for the discharge. Depending on where the water is discharged, technologies that may be used include oil/water separation, air stripping, steam stripping, adsorption, and precipitation. Discharge to a POTW such as PVSC is considered for the Early Action. Treatment for discharge to the PVSC treatment plant may be needed to reduce oil and grease levels in the discharge to below PVSC discharge limits. Metal concentrations in Phase 1 groundwater samples are below PVSC discharge limits, and therefore, treatment for metal removal is assumed not to be needed.
  - *Fluid Discharge* – The treated groundwater may be discharged to surface water or POTW. Discharge to groundwater is unlikely to be technically feasible because of shallow groundwater. Discharge to a POTW is retained because preliminary evaluations of discharge options performed as part of this FFS suggest that PVSC may accept the discharge. Discharging to PVSC may be significantly less costly than constructing an onsite treatment system to discharge to surface water.
  - *Fluid Disposal* – The recovered LNAPL would require transport and disposal at an offsite appropriately permitted facility.

- **Vapor Treatment** – Adsorption was retained as the technology to treat vapor emissions from treatment systems, should these exceed applicable regulatory thresholds.
- **Soil Excavation, Treatment, and Disposal** – The technologies retained include the following:
  - *Excavation* – This is the physical removal of LNAPL-contaminated soil to the target depth. Excavation is generally applicable to depths of less than 20 feet, which is the general limitation of standard excavation equipment. Excavation of soil below the shallow water table would require dewatering, water treatment, disposal of the treated water, and disposal of LNAPL recovered from the water.
  - *Treatment*
    - *Ex Situ Stabilization* – This technology involves adding a solidification agent such as cement to prepare the material for transportation and to meet LDRs, if needed.
    - *Ex Situ Soil Washing* – Surfactants, co-solvents, and/or acidic/basic solutions are used to cleanse soil and desorb and dissolve contaminants including residual LNAPL and other COPCs. Soil is processed in an onsite slurry reactor and water treatment facility. Soil can then be replaced onsite for disposal after LDRs are met.
  - *Disposal* – This technology involves the disposal of removed material at an offsite appropriately permitted landfill or backfilling onsite after treatment as well as disposal of the solutions from the soil washing.

The technologies/process options that were retained are expected to have varying degrees of effectiveness in reducing co-located chemical contamination identified during the Phase 1 RI activities. These reductions are mainly expected to occur as a result of a reduction in the mass of LNAPL following the application of the selected technology. Some technologies may have additional effectiveness on treating the chemical contamination adsorbed to the soil matrix. The table below shows the general applicability of the retained treatment technologies for LNAPL to the co-located chemical contamination identified in the soil during the Phase 1 RI.

		General Applicability of Remedial Technology / Process Option to co-located chemical contamination (1)				
Remedial technologies	**Process option**	**VOCs**	**SVOCs**	**Pesticides**	**Arochlors / PCBs**	**Metals**
Bioremediation	Aerobic bioremediation	Yes	Yes	Limited	Limited	No
	Anaerobic bioremediation	Yes	Yes	Limited	Limited	No
Excavate, treat, dispose (onsite or offsite)	Stabilization	Yes	Yes	Yes	Yes	Yes
	Soil washing	Yes	Yes	Yes	Yes	Yes
(1) Specific contaminants of potential concern (COPCs) identified in soil during the Phase 1 RI as exceeding NJ soil standards are listed under each class. There are no soil standards for individual arochlors. Total arochlor concentrations measured in soil during the Phase 1 RI exceeded the NJ standard for total arochlors but the individual arochlor concentrations were below this standard.		benzene, PCE, TCE, xylenes	PAHs, PCP	Aldrin, Dieldrin	Total concentrations (1)	Sb, AS, Ba, Be, Cd, Cu, Pb, Hg, Ni, Th, Va, Zn

Development of Remedial Action Alternatives

The next step in the feasibility study process is to group the remedial technologies/ process options that remained into remedial action alternatives.

The remedial action alternatives were developed to represent a wide range of remedial actions in terms of their cost and effectiveness in protecting human health and the level of difficulty in their implementation. With the exception of the baseline No Action Alternative, which is used to gauge the effectiveness of all other alternatives, all developed alternatives are expected to meet, to varying degrees, the RAOs established for the site. The alternatives also vary in the time and cost that they would require to achieve the established PRG.

As previously noted, the technologies/process options that were retained were assembled into "technology-/process option–based" remedial action alternatives.

Four "technology-/process option–based" remedial action alternatives were assembled. Because of the small number of alternatives that were assembled, this FFS proceeded in Section 4, directly to detailed evaluation of the alternatives rather than going through initial screening to narrow down the list of alternatives for detailed evaluation.

The assembled alternatives are summarized in Table 3-2 and below.

Alternative 1 – No Action

This is the baseline alternative against which the performance of the remaining alternatives is evaluated. This alternative includes performing 5-year reviews.

Alternative 2 – Construction and Operation of Onsite Biocell

This alternative includes the following:

- Perform pre-design investigation (including characterization sampling for disposal).
- Perform treatability testing and design and coordinate with various regulatory entities (for example, PVSC regarding the discharge of the water, NJDEP regarding air emissions).
- Excavate soil within areas where measureable thickness of LNAPL is found, treat via stabilization (if needed), and transport for offsite disposal. This component may change during the design but is included as potentially representative of highest costs; final determination will be made during the design.
- Excavate rest of soil, use sheet pile wall for shoring excavation, dewater excavation, treat water from dewatering, and dispose water to POTW.
- Augment excavated soil with nutrients and bulking agent to enhance permeability and conditions for biological activity and prepare to place back in constructed biocell.
- Construct biocell including piping to supply air and distribute nutrient additives, collection system for air and water that may accumulate in the biocell, and associated equipment.
- Place soil in biocell.
- Install cover.
- Operate and maintain aeration, nutrient distribution, and water collection systems:
  - Collect and dispose of water accumulated in the biocell to POTW
  - Operate air supply and nutrient delivery system
  - Maintain cover
- Perform performance sampling.
- Perform confirmation sampling.
- Remove sheet pile wall.
- Close biocell.
- Perform 5-year reviews until completion of remedy.

Alternative 3 – Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soil

This alternative includes the following:

- Perform pre-design investigation (including characterization sampling for disposal).

- Perform treatability testing and design and coordinate with various regulatory entities (for example, PVSC regarding the discharge of the water, NJDEP regarding air emissions).
- Excavate soil within areas where measureable thickness of LNAPL is found, treat via stabilization (if needed), and transport for offsite disposal. This component may change during the design but is included as potentially representative of highest costs; final determination will be made during the design.
- Excavate rest of soil, use sheet pile wall for shoring excavation, dewater excavation, treat water from dewatering, and dispose water to POTW.
- Treat soil via ex situ soil washing and place treated soil back into excavation.
- Transport and dispose of wastes from soil washing offsite.
- Remove sheet pile wall.
- Perform performance sampling.
- Perform confirmation sampling.

Alternative 4 – Excavation and Offsite Disposal

This alternative includes the following:

- Perform pre-design investigation (including characterization sampling for disposal).
- Perform design and coordinate with various regulatory entities (for example, PVSC regarding the discharge of the water, NJDEP regarding air emissions).
- Excavate soil, dewater excavation, use sheet pile for shoring excavation, treat water from dewatering, and dispose water to POTW.
- Stabilize excavated soil onsite and transport for offsite disposal.
- Backfill excavation with clean fill.
- Maintain sheet pile wall around RTA, but pull slightly up and create through grading a recharge area to maintain a positive gradient from within the RTA to the outside to prevent recontamination of the area by other COPCs.
- Perform confirmation sampling.

Table 3-3 details the components of the assembled remedial action alternatives. The estimated time required by each alternative to achieve the established RAOs and PRG also is provided in the table. Conceptual designs (approximately 30 percent complete) of the alternatives are presented in appendices. The conceptual designs include a schematic showing the system components and a preliminary layout of the system at the site. The system layout is based on vendor recommendations and literature values. The conceptual designs are based on the assumptions identified in this FFS. Five-year reviews would be needed for Alternatives 1 and 2 to assess how these are performing relative to the RAOs and PRG for the Early Action. As Alternatives 3 and 4 are expected to achieve the RAOs and PRG at the end of the construction period and before the end of the first 5 years from the start of alternative implementation, 5-year reviews are not needed for these alternatives. The purpose of the 5-year reviews would be only to evaluate alternative performance relative to the RAOs for this Early Action and not to include considerations of other contaminants left in media, as these will be addressed through subsequent actions.

SECTION 4

Detailed Evaluation of Remedial Action Alternatives

The "technology-/process option–based" remedial action alternatives developed in Section 3 are evaluated in this section against nine criteria defined in the NCP. The first seven criteria are addressed in this FFS. The last two criteria will be addressed by USEPA in the ROD for the site. The nine criteria are:

- Protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of TMV
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

This section is comprised of the following subsections:

- Description of evaluation criteria
- Results of detailed evaluation
- Comparative analysis of remedial action alternatives

Description of Evaluation Criteria

Provisions of the NCP require that each alternative be evaluated against nine criteria listed in 40 CFR 300.430(e)(9). These criteria were published in the March 8, 1990, *Federal Register* (55 FR 8666) to provide grounds for comparison of the relative performance of the alternatives and to identify their advantages and disadvantages. This approach is intended to provide sufficient information to adequately compare the alternatives and to select the most appropriate alternative for implementation at the site.

The criteria are divided into three groups: threshold, balancing, and modifying criteria. Threshold criteria must be met by for an alternative to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—either they are met by a particular alternative, or that alternative is not considered acceptable. The two threshold criteria are (1) overall protection of human health and the environment and (2) compliance with ARARs. If ARARs cannot be met, a waiver may be obtained in situations where one or more of the six exceptions listed in the NCP occur (see 40 CFR 300.430 (f)(1)(ii)(C)(1 to 6).

Unlike the threshold criteria, the five balancing criteria weigh the tradeoffs between alternatives. A low rating on one balancing criterion can be compensated by a high rating on another. The five balancing criteria are:

- Long-term effectiveness and permanence
- Reduction of TMV through treatment
- Short-term effectiveness
- Implementability
- Cost

The two modifying criteria—community acceptance and state acceptance— are evaluated following public comment and are used to change (or confirm) the selection of the recommended alternative.

The detailed remedial action alternative analysis is the method for evaluating technical and policy considerations to develop the rationale for selecting a remedy for a site. The following paragraphs describe each of the nine criteria.

Overall Protection of Human Health and the Environment

This evaluation criterion is an assessment of whether each remedial action alternative achieves and maintains adequate protection of human health and the environment. The overall appraisal of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Another consideration is the statutory preference for onsite remedial actions.

Compliance with ARARs

This evaluation criterion is used to determine whether a remedial action alternative will meet the federal, state, and local ARARs that were identified in Section 2. A discussion of the compliance of each remedial action alternative with previously identified chemical-, location-, and action-specific ARARs is included in this section.

Section 2 also describes the PRG that was selected for the Early Action.

Long-Term Effectiveness and Permanence

This criterion reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the long term as well as in the short term. The assessment of alternatives against this criterion evaluates the risk of residual contamination remaining after completing a remedial action or enacting the No Action Alternative and includes evaluation of the adequacy and reliability of controls.

Reduction of Toxicity, Mobility, and Volume

This criterion addresses the statutory preference for selecting remedial actions that use, as their principal element, technologies that permanently treat and significantly reduce the TMV of the hazardous substances. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic chemicals, reduction of the total mass of toxic chemicals, irreversible reduction of contaminant mobility, or reduction of total volume of contaminated media. When evaluating this criterion, an assessment is made as to whether treatment is used to reduce principal threats, including the extent to which TMV are reduced either separately or in combination with one another. Critical factors include the following:

- Treatment processes used by the remedy
- Amount of hazardous materials to be treated
- Degree of expected reduction in TMV
- Degree to which the treatment would be irreversible
- Type and quantity of treatment residuals that would remain following treatment
- Whether the remedial action alternative would satisfy the statutory preference for treatment as a principal element

Short-Term Effectiveness

This evaluation criterion addresses the effects of the remedial action alternative during the construction and implementation phase until the established RAOs and PRG are met. Remedial action alternatives would be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The following factors would be addressed for each remedial action alternative:

- Protection of the community during remedial actions
- Protection of workers during remedial actions
- Environmental impact during remedial actions
- Amount of time to achieve remedial objectives
- Air pollutant emissions

This FFS also includes under the short-term effectiveness considerations on whether the alternatives offer sustainability advantages.

Sustainable remediation concepts can be incorporated into remedial alternatives and offer benefits to the environment and lower costs. The potential for incorporating sustainability concepts into a remedial alternative can be used as a "balancing criteria" to allow comparison between alternatives without compromising the clean up objectives for a site. These balancing criteria support and enhance the remedy selection process and ultimately, the design and implementation of the selected remedy.

USEPA emphasizes the importance of utilizing cleanup strategies that use natural resources and energy efficiently, reduce negative impacts on the environment, minimize or eliminate pollution at its source, and reduce waste to the greatest extent possible. The practice of "green remediation" uses these strategies to consider all environmental effects of remedy implementation and incorporates options to maximize the net environmental benefit of cleanup actions.

In this FFS, we used the following core elements to perform a qualitative evaluation of the sustainability performance of each alternative:

- Energy Requirements of the Treatment System - The remedy uses low-energy demand technologies, can rely on onsite energy generation, and can be designed with equipment that is energy efficient.

- Air Emissions - The remedy is expected to have less air emissions (especially greenhouse gases), it would minimize use of heavy equipment requiring high volumes of fuel, require less vehicular traffic and truck idling, and can be designed to minimize dust generation.

- Water Requirements and Impacts on Water Resources - The remedy would have lower requirements for the use of fresh water, can re-use treated water, would use native vegetation that would require little to no irrigation, and would prevent impacts such as nutrient loading on water quality in nearby water bodies.
- Land and Ecosystem Impacts - The remedy would use passive energy technologies such as bioremediation, minimize habitat disturbance (e.g., impacts on the wetland area), and reduce noise and lightning disturbance.
- Material Consumption and Waste Generation - The remedy would result in less waste residuals as it uses technologies that generate less waste, can reuse/reclaim/recycle materials, reduces / eliminates the need for removal of media for offsite disposal, and uses passive sampling where feasible, to minimize waste generation.
- Long Term Stewardship - The remedy would result in less greenhouse gases contributing to climate change, integrate an adaptive management approach into the long-term controls for the site, use renewable energy to power long-term activities, use passive sampling devices for long-term monitoring where feasible, and solicit community involvement to increase public acceptance and awareness.

Implementability

The implementability criterion addresses the technical and administrative feasibility of executing an alternative and the availability of various services and materials required during its implementation. Technical feasibility includes construction, operation, reliability of technology, ease of undertaking additional remedial action, and monitoring. Administrative feasibility refers to the activities needed to coordinate with other offices and agencies (local permits, for example). Availability of services and materials includes availability of adequate off-facility treatment, storage capacity, and disposal services; necessary equipment and specialists; services and materials; and prospective technologies.

Cost

The cost estimates for this section are order-of-magnitude cost estimates that provide an accuracy of +50 percent to -30 percent. They are based on the assumptions outlined in this FFS report and were prepared using USEPA's *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA 2000). All present worth values are based on real discount rates from Appendix C of the Office of Management and Budget (OMB) Circular A-94, Appendix C (revised January 2003). The 30-year value of 2.7 percent was selected since worst-case operations and maintenance (O&M) duration (no action) is assumed to be over 30 years and all options should be compared on the same basis. This estimate is limited to the conditions existing at its issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as, but not limited to local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc. may affect the accuracy of this estimate.

Capital costs consist of direct and indirect costs. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses, license or permit costs, and contingency allowances.

Annual O&M costs are the post-construction costs required for the continued effectiveness of the remedial action. Components of annual O&M costs include the cost of operating labor, maintenance materials and labor, auxiliary materials and energy, residue disposal, purchased services, administration, insurance, taxes, licensing, maintenance reserve and contingency funds, rehabilitation, monitoring, and periodic site reviews.

Expenditures that occur over different periods were analyzed using present-worth, which discounts all future costs to a base year. Present-worth analysis allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the remedial project. Assumptions associated with the present-worth calculations include a discount rate of 2.7 percent before taxes and after inflation, cost estimates in the planning years in constant dollars, and a period of performance based on the time estimated that each remedial action alternative would need to meet the established PRG.

The cost estimates are in 2009 dollars and were prepared on the basis of site information available at the time of preparation of this report. The costs reflect the areas, volumes and concentrations estimated to require remedial action in this FFS. Additional investigation activities will be performed at the beginning of the remedial design. On the basis of the collected additional information, it may be determined that different areas and volumes require remedial action, which will affect the cost estimates presented in this FFS.

The cost estimates were prepared using vendor quotes and information from various USEPA technology databases and technology reference documents available at the time of preparation of this report. Treatability studies were not performed as part of this FFS but should be performed before proceeding with the detailed full-scale system design.

In summary, the cost estimates in this FFS were prepared for guidance in project evaluation and implementation. The actual cost of each remedial action alternative would depend on the final areal and volumetric coverage and the design of the remedial action alternative following the performance of pre-design investigation and treatability studies; the effectiveness of the technology under site conditions as demonstrated during the treatability studies and full-scale system operation; competitive market conditions; actual labor and material costs; and other variables. Although these factors will affect the cost of each remedial action alternative, they are not expected to affect the relative cost differences between remedial action alternatives for the purpose of comparing remedial action alternatives. The final costs will, however, likely vary from the estimates presented in this report, so funding needs must be carefully reviewed before specific financial decisions are made or final budget is established.

State Acceptance

State acceptance will be addressed in the Proposed Plan. It indicates whether, based on its review of the RI/FS report and the Proposed Plan, the State concurs with, opposes, or has a comment on the preferred remedy.

Community Acceptance

Community acceptance will be addressed in the Proposed Plan. It refers to the public's general response to the preferred remedy described in the Proposed Plan.

Results of Detailed Evaluation of Remedial Action Alternatives

Table 4-1 presents the results of the detailed evaluation of each alternative against the criteria identified above.

Comparative Evaluation of Remedial Action Alternatives

This section compares the four remedial alternatives against each other to evaluate the relative performance of each alternative in relation to each of the criteria. In summary, all alternatives (other than the No Action Alternative) are viable and expected to achieve the PRG and are therefore, considered to offer similar overall protectiveness to local public health and the environment and compliance with ARARs. The three alternatives, however, differ in the amount of residual LNAPL each may leave following completion, the time they would need to achieve the PRG, the manner in which the objectives are achieved (whether treatment is used and the type of treatment or whether LNAPL is transferred for offsite disposal), the nature and volumes of the wastes resulting from their implementation, and cost. These issues are discussed in more detail below.

Overall Protection of Human Health and the Environment

Alternative 1 (no further action) would not provide protection as this alternative does not include any actions to address the presence of the principal threat LNAPL at the site.

The remaining three alternatives would provide protection to local human health and the environment, as all three actively address the principal threat LNAPL by biodegradation, soil washing, or excavation and removal from the site.

All three are expected to achieve the PRG and are therefore considered to offer similar overall protectiveness to local public health and the environment. The PRG are expected to be achieved more quickly by Alternatives 3 and 4 (1 year and 8 months, respectively) than by the other two alternatives. The time to achieve the PRG by Alternative 2 is estimated to range between 3 to 8 years following the 1 year of construction. For the purpose of estimating the costs in this FFS, the operational time is assumed to be 5 years although it is possible it extends beyond this estimated duration. For this FFS, Alternative 1 is assumed to serve as the baseline with the PRG being achieved in 30 years or greater, although the actual duration may be significantly higher.

Alternatives 2 and 3 rely on treatment to achieve the PRG. Alternative 2 uses biological degradation to destroy principal threat LNAPL, while Alternative 3 uses soil washing to remove the principal threat LNAPL from soil and transfer it to treatment residuals. As such, both alternatives may leave some residual LNAPL following implementation. Alternative 4 does not include treatment; it relies on the excavation and offsite disposal of the soil containing the principal threat LNAPL. As such, no LNAPL would be left within the RTA.

Alternatives 2, 3, and 4 would provide protection to groundwater and surface water at the site, as all three address the primary source of contamination to these media. Of the three alternatives, Alternative 4 provides the greatest confidence that the principal threat LNAPL source would be removed from the site; as noted, however, this alternative transfers LNAPL-contaminated soil to an offsite location. Alternatives 2 and 4 provide similar protection to groundwater and surface water by removing LNAPL from the soil; however, under both alternatives, some residual LNAPL may remain.

Compliance with ARARs

Alternatives 2, 3, and 4 can be designed to meet ARARs applicable to the principal threat LNAPL and comply with the substantive requirements of the applicable laws and regulations. It should be noted that all three alternatives require the disturbance of the onsite wetlands. Restoration of the wetlands is not included in these alternatives, as a significant full-scale remediation effort is expected to follow this Early Action. Therefore, wetland restoration will need to be considered as part of the overall remedial action for the site.

Long-Term Effectiveness and Permanence

Alternative 1 would not result in any change in the risk associated with the principal threat LNAPL at the site, as this alternative does not involve any remedial actions.

For Alternatives 2 and 3, the potential risks from the principal threat LNAPL would be reduced over their implementation periods, although both alternatives may leave some residual LNAPL in the RTA soil. Alternative 4 eliminates this risk from principal threat LNAPL within the RTA since clean fill would be imported to the site. Under all three alternatives, LNAPL contamination would remain outside the RTA.

The three alternatives differ in the amount of LNAPL each may leave at the site following completion. Alternatives 2 and 3 rely on treatment to achieve the PRG. Alternative 2 uses biological degradation to destroy principal threat LNAPL, while Alternative 3 uses soil washing to remove the principal threat LNAPL from soil and transfer it to treatment residuals. As such, Alternative 2 may leave residual of larger carbon-content petroleum compounds following implementation. Alternative 3 will likely leave less residual, as soil will be physically washed and chemically treated with surfactants to remove LNAPL. Alternative 4 does not include treatment; it relies on the excavation and offsite disposal of soil containing the principal threat LNAPL. As such, no residual LNAPL would be left within the RTA.

Other than water from the excavation and biocell dewatering during operation, no treatment residuals are expected from Alternative 2. Treatment residual, in addition to water from dewatering, is expected from Alternative 3; the concentrations of principal threat LNAPL and associated contaminants are expected to be high in these residuals (filter cake, blowdown water from soil washing). The residuals from Alternative 3 are assumed to require offsite treatment and disposal, thus transferring the risk offsite. Proper characterization and permitted facilities would be used to manage these risks. During treatability testing and design, opportunities for biological treatment of the filter cake also will be evaluated. There are no treatment residuals (other than water from dewatering) for Alternative 4, as this alternative involves the excavation and offsite disposal of soil without onsite treatment.

For this FFS, all three alternatives are assumed to include the use of a sheet pile wall to isolate the RTA. Under Alternative 2, this wall covers the perimeter of the biocell and would be left in place during the biocell operation, resulting in significant cost. At the end of the implementation period, the sheet pile wall would be removed as the soil within the RTA is expected to be of similar characteristics to the surrounding soil. The removed sheet pile wall is expected to have salvage value, and this consideration is included in the cost estimate.

For Alternative 3, excavation and treatment would proceed one cell at a time, and therefore, the length of sheet pile wall needed is much shorter (the perimeter of one cell with the sheet pile wall reused from cell to cell). Similar to Alternative 2, at the end of the implementation period, there would not be an isolation barrier around the RTA, as the soil within the RTA is expected to be of similar characteristics to the surrounding soil.

Under Alternative 4, the sheet pile wall around the perimeter of the RTA would need to be pulled up and cut below grade, leaving an isolation barrier between the RTA and the surrounding soil. This isolation barrier would be needed as the soil within the RTA is expected to contain no LNAPL and no other contaminants compared to the soil surrounding the RTA. The surface would need to be graded to drain clean surface water toward the RTA such that there is a slight positive gradient from within the RTA to the outside.

It should be noted that other options to sheet piling are available and may be used depending on the final RTA layout. This is further discussed under the cost sensitivity section.

Reduction of Toxicity, Mobility, and Volume (TMV) Through Treatment

Active treatment is not used in Alternative 1, and therefore, no significant reductions in TMV would occur since natural attenuation of the LNAPL is expected to be negligible.

Alternatives 2, 3, and 4 offer reductions in the TMV of the principal threat LNAPL within the RTA. The three alternatives differ in how the reduction is achieved and the degree of the reduction and, therefore, residual LNAPL left in soil. All three alternatives include excavation of the areas where LNAPL is found in monitoring wells and would result in reductions in LNAPL toxicity and volume within these areas.

For the remaining RTA, Alternatives 2 and 3 rely on treatment to achieve reductions in toxicity and volume. Alternative 2 achieves this through in situ biological destruction of principal threat LNAPL. Alternative 3 relies on soil washing to reduce the toxicity and volume in the treated soil but the LNAPL is transferred to the resulting treatment residuals, which require offsite disposal (thus transferring the toxicity and volume offsite). The amount of LNAPL left in the soil is expected to differ under the two alternatives and may be less for Alternative 4 where more robust ex situ treatment is used.

Alternative 4 does not use treatment – rather the toxicity and volume are transferred through offsite disposal.

For Alternatives 2 and 3, the treatment is irreversible.

The mobility criterion covers the mobility of the principal threat LNAPL, leachability of contaminants from LNAPL to groundwater, and migration of contaminants released from LNAPL into soil gas. All three alternatives address the mobility of the principal threat LNAPL through treatment or through its removal for offsite disposal. All three alternatives also address the fraction of volatile organics in LNAPL and are expected to reduce the mobility of this fraction through leachability and volatilization into soil gas. This reduction is expected to differ between alternatives with Alternatives 3 and 4 performing better than Alternative 2.

Alternative 2 would result in reductions of VOCs through the degradation of LNAPL material, but it is not expected to have an effect on other COPCs found in soil (for example, metals). This alternative is likely to leave more residuals (LNAPL and COPCs) in the treated soil than the soil washing alternative, although the alternative is expected to achieve the PRG set for the principal threat LNAPL. If desired, the biocell can be left intact in place and used as part of a future overall remedial action for the site. For example, the distribution piping could be used for distributing chemicals for anaerobic biodegradation. This would allow cost-saving benefits for potential future remedial actions with the same RTA that seek to further address biodegradable VOCs.

Alternative 3 offers flexibility in that the soil washing process can be designed to treat other COPCs found in soil within the RTA. Using a robust soil washing process, it would be possible to treat both LNAPL and COPCs in soil to levels that would be below the New Jersey cleanup standards for nonresidential use. The cost and duration for such treatment are expected to be higher than presented in this FFS, and would require treatability testing to confirm. Treating for other COPCs within the RTA to the New Jersey nonresidential cleanup standards would only provide an advantage if this is consistent with the future overall remedial action for the site. An isolation barrier should be considered to prevent recontamination if soil within the RTA is treated to these levels while the surrounding soil is not.

Short-Term Effectiveness

Because there would be no remedial construction activities associated with Alternative 1, this alternative has no short-term risks associated with its implementation.

Alternatives 2, 3, and 4 include construction activities of varying duration and with varying potential concerns for construction workers, the community, and the environment.

Alternatives 2, 3, and 4 would present some short-term risks to the community (dust, emissions, soil erosion); these risks can be controlled through engineering controls. Risks to workers during implementation also can be controlled through safety procedures and the use of personal protection. As noted earlier in this FFS, there are no residences within 0.5 mile of the site. Short-term concerns would relate to potential impacts on industrial and commercial neighbors.

Risks associated with construction activities for all alternatives include vapors, dust, possible odor, and soil/sediment erosion. All of the alternatives involve excavating the RTA soil. Risks to commercial and industrial neighbors can be controlled through engineering controls such as soil erosion controls, dust suppressants, and the implementation of spill prevention and response procedures. Risk to workers also can be controlled by using safety procedures and protective equipment.

Based on the excavation rates and the rates of air supply through the biocell, VOC emissions from the implementation of each alternative were estimated. These were below regulatory levels requiring air emissions controls for all alternatives; this will need to be confirmed during the remedial design.

The short-term risk associated with Alternative 4 would be the highest because of its significant transportation component (both contaminated soil and clean borrow need to be transported from and to the site). Smaller volumes of residuals would require offsite disposal under Alternative 3, although this alternative involves onsite soil washing, which is generally a complex process that requires close oversight and management for proper performance and operation.

The short-term risks are expected to be the lowest for the biocell construction and operation, although import of soil augmentation materials would be required via trucking.

Table 4-2 presents the qualitative evaluation of the performance of the developed alternatives relative to the sustainability core elements described earlier in this section. The comparison in Table 4-2 is qualitative with the number of check-off marks used to indicate relative performance between alternatives (for example, a higher number of check-off marks indicates better performance of an alternative compared to the other alternatives).

For the selected remedial alternative, the sustainability elements identified in Table 4-2 could be integrated into the remedial design through specific alternative components (for example, use of solar panels to provide energy). Note that although costs associated with this integration are not currently included in the cost estimates, the additional cost is likely not significant with respect to the total estimates provided and may result in overall cost savings (for example, the use of renewable energy to offset utility costs).

Alternative 2 is considered the most sustainable under the sustainability core elements listed above. This alternative would generate significantly less solid waste compared to the other alternatives as it relies on the degradation of the principal threat LNAPL rather than its transfer offsite. However, this alternative would generate a significant amount of water from the dewatering during biocell operation that would require discharge and treatment by an offsite treatment plant. Although materials would need to be brought to the site for the biocell construction, overall, the need for truck traffic is expected to be less than for the other alternatives - thus resulting in less air emissions, dust, and other related concerns. Alternative 2 has less water demands than Alternative 3, and components of this alternative can be incorporated into a future overall remedial action for the site. While this alternative is estimated to require from 3-8 years (assumed 5 years in this FFS) of continuous operation with associated energy demand, sources of renewable energy can be incorporated into its design to maximize energy efficiency.

Alternatives 3 and 4 are considered less sustainable under the sustainability core elements listed above, with Alternative 4 being the least sustainable alternative. This is because this alternative relies on the excavation of the soil which would entail transportation of the soil for offsite disposal and transportation to the site of clean fill. If trucking is used, , energy consumption, would be high and this alternative would result in significant amounts of greenhouse gas emissions. Rail road transportation can also be considered but its use would depend on the location of the facility that accepts the excavated soil.

Of note, all three alternatives require disturbance of the wetland area and do not include sustainable elements under this theme. This would be addressed as part of the overall remedy for the site.

Implementability

Alternative 1 is very implementable, as there are no associated actions.

Alternatives 2, 3, and 4 also are considered implementable from a constructability perspective. Possible challenges common to all three alternatives include sheet pile refusal, excavation dewatering and water treatment, phasing cell construction, and uncertainties in the depth to and variability of the native clay layer.

Because of the complexities of the equipment and process, the soil washing technology is expected to have a higher potential for delays associated with equipment problems. Preparation of the material for placement in the biocell and for the feed to the soil washing process is critical for both alternatives, although probably more for the soil washing process because of the equipment requirements.

The monitoring techniques that would be used for Alternatives 2 and 3 are standard, readily available, and expected to provide the needed information to assess the progress of the technologies toward the PRG.

Alternative 2 would require operations and maintenance over a longer period (assumed 5 years of operations in this FFS) than Alternatives 3 and 4. The operations and maintenance activities needed for this alternative are routine, and failure of a component of the alternative is not expected to result in any significant threats to public health or the environment. Process monitoring and controls would be used to monitor performance.

In terms of administrative implementability, all three alternatives would require coordination with the Kearny Municipal Authority and Passaic Valley Sewerage Commission with regard to sewer connections and discharge of treated water. Coordination with the NJDEP and other regulatory agencies also would be needed to coordinate compliance with substantive regulatory requirements (that is, air emissions monitoring, wetlands, erosion controls). In addition to these, Alternative 4 would require significant coordination with disposal facilities.

Equipment and specialists are commercially available and sufficiently proven for all three alternatives, although less vendors are available for competitive bidding for the soil washing technology. Vendors of the soil washing process differ in the process components and materials that they use, and they would need to adapt their process to the specifics of the Diamond Head site. Alternative 4 would require significant coordination to reserve disposal capacity, although there is no indication that this cannot be achieved. Alternative 2 is considered the most favorable in terms of availability of services and materials.

Cost

The present worth cost for alternatives are listed in Table 4-3 and detailed in Appendices B through D. The cost estimate tables break down the estimated capital, operations and maintenance costs, periodic costs, and present worth values for the alternatives. There are no costs associated with Alternative 1. Only Alternative 2 has associated operations and maintenance costs (see footnote to Table 4-3 for the annual operations and maintenance costs).

Cost Uncertainties

There are several uncertainties associated with the cost estimates for the three alternatives. Some of these uncertainties relate to the need for better definition of the RTA and therefore, better estimates of the quantities under the various line items in the cost estimates.

One line item in particular – the use of sheet pile wall during construction – has a significant impact on the total costs for all three alternatives.

Each alternative uses a sheet pile wall to isolate the cells, support the excavation side walls, and minimize infiltration of groundwater during excavation. For the purposes of this FFS, a sheet pile wall with sealed joints was assumed (for example, Waterloo Barrier™) to minimize water infiltration from outside the RTA. Other methods could be used to shore the excavations. This may include DeWind One-pass Trenching® and installation of vertical membrane liner materials, use of standard (not low-permeability) sheet pile walls, or using traditional excavation slopes to achieve shoring (that is, 2:1 horizontal to vertical slopes). The method can be selected during the remedial design and will affect the volume of water from dewatering during construction and operation, the amount of soil requiring excavation, and in the case of a vertical liner, may require additional effort to remove the liner after implementation is complete.

The costs for these alternate isolation methods are not estimated as part of this FFS, but overall, are expected to be less than the low-permeability sheet pile wall included in each of the three alternatives. In order to provide information on the sensitivity of the costs relative to the assumed isolation method, a range in costs is provided in Table 4-3. The low end of the range represents the cost of the alternative without any sheet pile wall or isolation methods, and without any additional dewatering or excavation efforts; therefore, this estimate is considered low and actual costs will be higher. The high end of the range includes the use of the low-permeability sheet pile wall. The use of alternate isolation methods in the alternatives is expected to result in actual costs that are lower than this estimate.

Another item that will impact the total costs for Alternative 2 (but not for Alternatives 3 and 4) is the duration of the period of operation required to achieve the PRG. The duration of construction for all three alternatives can be estimated fairly well. At the end of the construction period, Alternatives 3 and 4 are expected to have achieved the established PRG. Alternative 2, however, would require an additional period of operation to accomplish this. The duration of this period is estimated to be between 3 to 8 years but will need to be ascertained during bench-scale testing and initial biocell operation. While only limited biodegradation is expected to be needed to achieve the PRG for the principal threat LNAPL, the timeframe could extend upto 10 years if biodegradation of the large carbon petroleum compounds proves critical to achieving PRG. For the purpose of estimating the costs in this FFS, the duration of needed operation was assumed to be 5 years. While this duration may extend, the annual operations and maintenance costs (while continuing to contribute to the total costs for this alternative), are anticipated to be small relative to the total costs of the alternative (please refer to Table 4-3).

Uncertainties associated with Alternatives 3 and 4 are described below.

- Soil Washing - The level of design detail available from the vendors was more limited than the other alternatives, and therefore handled through increased contingency. Bench-scale testing will be critical to define the required process for the Diamond Head site (for example, chemicals and soil washing methods) and strength and magnitude of residuals (such as filter cake) and associated pre-treatment and disposal methods.
- Excavation - Excavation, hauling, and disposal facilities were consulted to develop this alternative; however, capacity may still be an issue. Uncertainty also exists with regard to the ability of maintaining regrading of the site during redevelopment in order to direct surface runoff to the RTA as well as with regard to partial sheet piling to mitigate recontamination of clean fill. Some long-term pumping may be needed as a contingency to prevent surrounding contaminated groundwater from flowing into the RTA until the full-scale remedy is complete. There also will be considerations on how any isolation system left in place would be incorporated into future redevelopment plans for the site.

SECTION 5

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Tables

Table 2-1 Potential Chemical-Specific Applicable or Relevant and Appropriate Requirements
Diamond Head Oil Superfund Site, Kearny, New Jersey

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
Resource Conservation and Recovery Act	**Identification and Listing of Hazardous Waste**	**40 CFR 261**	**Defines those solid wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and 270.**	**ARAR for wastes or treatment residues which are hazardous as defined by RCRA and are to be disposed of off-site.**	**Applicable for the disposal of hazardous solid wastes (LNAPL impacted soils) and LNAPL impacted groundwater or groundwater that meets the hazardous waste characteristic thresholds**
Federal Safe Drinking Water Act	National Primary Drinking Water Standards - Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Levels (MCLs)	40 CFR 141	Establishes health-based standards for public drinking water systems. Also establishes drinking water quality goals set at levels at which no adverse health effects are anticipated, with an adequate margin of safety. The NCP specifically states that MCLs will be used as ARARs for useable aquifers rather than the more stringent MCLGs.	ARARs for groundwater concentrations following remediation but there are no MCLs for LNAPL.	
Federal Safe Drinking Water Act	National Secondary Drinking Water Standards- Secondary MCLs	40 CFR 143	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water (secondary MCL).	ARARs for groundwater concentrations following remediation but there are no MCLs for LNAPL.	
Quality Criteria for Water	Water Quality Criteria	40 CFR 131 Quality Criteria for Water, 1976, 1980, and 1986	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	ARARs. If treated water needs to be discharged to surface water, these will be used in setting effluent discharge limits. Water discharge planned to POTW.	
Federal Clean Water Act; National Pollution Discharge Elimination System (NPDES)	Toxic Pollutant Effluent Standards	40 CFR 129	Establishes effluent standards or prohibitions for certain toxic pollutants; I.e., aldrin/dieldrin, DDT, DDD, DDE, endrin, toxaphene, benzideine, and PCBs.	ARARs. If treated water needs to be discharged to surface water, these will be used in setting effluent discharge limits. Water discharge planned to POTW.	
National Ambient Air Quality Standards (NAAQS)	Ambient Air Quality Standards	40 CFR 50	Defines air quality levels adequate to protect public health/welfare. Defines emissions limitations for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen oxide, and lead.	ARARs for remedial alternatives resulting in air emissions if toxic pollutants are present.	Become ARARs if site air emissions exceed major facility thresholds below. This is not expected. • Carbon monoxide, particulate matter, Sulfur dioxides >= 100 tons/year • Nitrous Oxides, VOCs, Total HAPs >=25 tons/year

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
					• Lead, Any HAP >= 10 tons/year • All other contaminants, except CO2 >= 100 tons/year
Federal Resource Conservation and Recovery Act	Groundwater Protection Standards and Maximum Concentration Limits	40 CFR 264, Subpart F	Establishes standards for groundwater protection for several metals and pesticides.	ARARs for groundwater concentrations following remediation. Note that there are no standards for LNAPL.	
Sludge Quality Criteria	Criteria for Sludge	NJAC 7:14-4 Appendix B-1	New Jersey Water Pollution Control Act Contaminant Indicators.	Potential ARAR if remedial alternative results in the generation of sludges during groundwater or soil treatment. Developed alternatives are not anticipated to result in sludge.	
State of New Jersey Statutes and Rules	**Technical requirements for remediation of free product.**	**7:26E-1**	**Require removal or treatment of recoverable LNAPL where practicable; treatment of residual LNAPL where practicable; containment of potentially mobile LNAPL where removal or treatment are not practicable.**	**ARAR for the remediation of the LNAPL.**	**Approval for the onsite biocell alternative requires approvals / coordination with NJ's Site Remediation Program (SRP). To gain approval to use the onsite biocell technology, the effectiveness of the method must be demonstrated and documented for the SRP.**
New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria	Residential Soil Cleanup Standards in New Jersey	N.J.A.C. 7-26D	Direct contact cleanup criteria for soils at residential sites.	TBC. Not promulgated. NJDEP requires delineation of contamination to residential levels.	This is an early action focusing on addressing LNAPL. These standards would be applicable to the final remedy for the site.
NJDEP Non-Residential Direct Contact Soil Cleanup Criteria	Non-Residential Soil Cleanup Standards in New Jersey	N.J.A.C. 7-26D	Direct contact cleanup criteria for soils at industrial or commercial sites.	TBC. Not promulgated. Criteria may be considered in setting cleanup goals for contaminated soils at source areas or areas where industrial activities are planned.	This is an early action focusing on addressing LNAPL. These standards would be applicable to the final remedy for the site.
NJDEP Impact to Groundwater Soil Cleanup Criteria	**Soil Cleanup Standards that are Protective of Groundwater in New Jersey**	**N.J.A.C. 7-26D**	**Soil cleanup criteria for protection of groundwater.**	**TBC. Not Promulgated. Criteria may be considered in setting cleanup goals for contaminated soils at source areas.**	**This is an early action focusing on addressing LNAPL. These standards are TBCs for the final remedy for the site. While there are no numeric soil criteria for LNAPL, these criteria were**

400101

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
					considered in developing the PRGs for the early action.
State of New Jersey Statutes and Rules	**Groundwater Quality Standards**	**N.J.A.C. 7:9-6 Groundwater Quality Standards**	**Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups.**	**ARAR for Class IIA aquifers.**	**This is an early action focusing on addressing LNAPL. These standards would be applicable to the final remedy for the site. While there are no numeric soil criteria for LNAPL, these criteria were used to develop PRGs for the early action.**
State of New Jersey Statutes and Rules	Drinking Water Standards- Maximum Contaminant Levels (MCLs)	N.J.A.C. 7:10 Safe Drinking Water Act	Establishes MCLs that are generally equal to or more stringent the SDWA MCLs.	ARARs for groundwater concentrations following remediation but there are no MCLs for LNAPL.	
State of New Jersey Statutes and Rules	National Secondary Drinking Water Standards- Secondary MCLs	N.J.A.C. 7:10-7 Safe Drinking Water Act	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water.	ARARs for groundwater concentrations following remediation but there are no MCLs for LNAPL.	
New Jersey Pollutant Discharge Elimination System (NJPDES)	Surface Water Discharge Criteria	N.J.A.C. 7:14a	Establishes discharge standards when written into permits.	ARARs. If treated water needs to be discharged to surface water, these will be used in setting effluent discharge limits. Water discharge planned to POTW.	
Surface Water Criteria	New Jersey Criteria for Surface Water Quality	N.J.A.C. 7:9-4	Criteria for surface water classes	TBCs. If treated water needs to be discharged to surface water, these will be used in setting effluent discharge limits. Water discharge planned to POTW.	
Prohibition of Air Pollution and Ambient Air Quality Standards	**Air Quality Standards**	**N.J.A.C. 7:27-5 and N.J.A.C.7:27-13**	**Prohibits air pollution and establishes ambient air quality standards**	**Potential ARAR for remedial alternatives which include technologies that result in odors and air emissions.**	**Provides the air quality and odor standards associated with potential emissions from aeration activities associated with the onsite biocell technology.**

400102

Table 2-2 Action-Specific Applicable or Relevant and Appropriate Requirements
Diamond Head Oil Superfund Site, Kearny, New Jersey

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
Discharge of Groundwater or Wastewater					
Federal Clean Water Act	National Pollution Discharge Elimination System (NPDES)	40 CFR 122 and 125	Issues permits for discharge into navigable waters. Establishes criteria and standards for imposing treatment requirements on permits.	ARAR for the disposal of groundwater to surface water, although state ARAR takes precedence for discharge permit. Water discharge planned to POTW.	
Federal Clean Water Act	**General Pretreatment Regulations for Existing and New Sources of Pollution**	**40 CFR 403**	**Prohibits discharge of pollutants to a POTW which cause or may cause pass-through or interference with operations of the POTW.**	**ARAR. Discharge of pollutants including those that could cause fire or explosion or result in toxic vapors or fumes to POTW.**	**POTW ARARs and thresholds supersede the Federal Standards.**
Federal Clean Water Act	Effluent Guidelines and Standards for the Point Source Category	40 CFR 414	Requires specific effluent characteristics for discharge under NPDES permits.	ARAR for the disposal of groundwater to surface water, although state ARAR takes precedence for discharge permit. Water discharge planned to POTW.	
Federal Clean Water Act	Ambient Water Quality Criteria	40 CFR 131.36	Establishes criteria for surface water quality based on toxicity to aquatic organisms and human health.	ARAR if remedial alternative includes groundwater discharge to surface water. Federally-approved New Jersey groundwater and surface water standards take precedence over the Federal criteria. Water discharge planned to POTW.	
Federal Clean Water Act	Water Quality Criteria Summary		Includes non-promulgated guidance values for surface water based on toxicity to aquatic organisms and human health. Issued by the EPA office of Science and Technology, Health and Ecological Criteria Division.	ARAR if remedial alternative includes groundwater discharge to surface water. Supplements above-referenced Ambient Water Criteria. Water discharge planned to POTW.	
Federal Safe Drinking Water Act	Underground Injection Control Program	40 CFR 144	Establishes performance standards, well requirements, and permitting requirements for groundwater re-injection wells.	ARAR if remedial alternative includes re-injection of treated water. May also apply to the injection of surfactants or oxidants into the aquifer.	
Water Pollution Control Act	Protection of water	33 U.S.C. 1251	Protects and maintains the chemical, physical, and biological integrity of the nation's water.	ARAR for remedial actions which may affect water quality.	
Water Treatment and Disposal					

400103

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
Effluent Limitations	**Discharge requirements**	**33 U.S.C. 1251 Section 301**	**Technology-based discharge limitations for point sources of conventional, nonconventional, and toxic pollutants.**	**ARAR for remedial actions which include discharge of wastewater.**	
Water Quality Related Effluent Limitations	Discharge requirements	33 U.S.C. 1251 Section 302	Protection of intended uses of receiving waters (e.g., public water supply, recreations uses).	ARAR for remedial actions which include discharge of wastewater. Water discharge planned to POTW.	
Toxic and Pretreatment Effluent Standards	**Pretreatment standards for discharge into POTWs.**	**33 U.S.C. 1251 Section 307**	**Establishes list of toxic pollutants and promulgates pretreatment standards for discharge into POTWs.**	**ARAR for remedial actions which include discharge of wastewater to POTW.**	**ARAR requirements to be established through permit.**
National Pollutant Discharge Elimination System (NPDES)	Permitting for discharge into navigable waters.	33 U.S.C. 1251	Issues permits for discharge into navigable waters.	ARAR for remedial actions involving discharge to surface water. Water discharge planned to POTW.	
New Jersey					
State of New Jersey Statutes and Rules	The New Jersey Pollutant Discharge Elimination System	N.J.A.C. 7:14A	Establishes standards for discharge of pollutants to surface and groundwaters.	ARAR for the disposal of groundwater to surface water. Water discharge planned to POTW.	
State of New Jersey Statutes and Rules	**Groundwater Quality Standards**	**N.J.A.C. 7:9-6 Groundwater Quality Standards**	**Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups and discharges to groundwater.**	**ARAR if disposal of treated groundwater by reinjection is needed. Also ARAR for groundwater quality at the site. TBC for this early action.**	**This is an early action focusing on addressing LNAPL. These standards would be applicable to the final remedy for the site. While there are no numeric soil criteria for LNAPL, these criteria were considered to develop PRGs for the early action.**
Kearny Municipal Utilities Authority (MUA)	**Receives wastewater in South Kearny and the Meadowlands Area**	**Local Limits**	**Establishes the standards for discharge of groundwater through the MUA's sewage system to PVSC.**	**ARAR for the discharge of groundwater to the PVSC.**	**All but the No Action alternative would require the management of groundwater generated during the implementation of the early action. Discharge to a POTW was selected as the representative process option for managing the generated groundwater. Discharge of the groundwater to the Passaic Valley Sewerage Commission (PVSC) treatment plant was considered in this FFS.**
Passaic Valley Sewerage Authority (PVSC)	**Receives wastewaters from the Kearny MUA**	**N.J.A.C. 7:14A and PVSC Local Limits**	**Establishes the standards for the discharge of waters from the Kearny MUA into their sewage system.**	**ARAR for the disposal of groundwater to the POTW, received by direct discharge and by truck load.**	**Discharge can be via a connection sewer or by trucking to PVSC. The**

400104

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
					nearest sewer line where the connection can be made was identified at the intersection of Bergen Avenue and Harrison Avenue; this sewer line is expected to be activated later this year. This sewer line is operated by the Kearny Municipal Authority (MUA). A permit would need to be obtained that would specify the requirements for discharging to PVSC. PVSC has discharge limits for metals and oil and grease (average of <100 mg/l or maximum of 150 mg/l). The metal concentrations in groundwater at the site are below the PVSC limits. There is no data for oil and grease in groundwater at the site. Therefore, this FFS assumes that some form of treatment would be needed to achieve the discharge limits for oil and grease. The pre-design investigation would collect data on oil and grease and the design would determine the need for and actual type of treatment for oil and grease. While PVSC does not have discharge limits for Total Suspended Solids (TSS), the permit that would need to be obtained for the discharge may specify a limit. We have assumed that treatment of the discharge for VOCs and other contaminants will not be required and that the permit will set the monitoring requirements. This FFS assumes that monthly monitoring and reporting will be required.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
State of New Jersey Statutes and Rules	Surface Water Quality Standards	N.J.A.C. 7:9B Surface Water Quality Standards	Establishes standards for the protection and enhancement of surface water resources.	ARAR for the disposal of groundwater to surface water. Water discharge planned to POTW.	
State of New Jersey Statutes and Rules	Wastewater discharge requirements	N.J.A.C. 7:9-5.1	Minimum treatment requirements and effluent standards for discharge to surface water.	ARAR for the disposal of groundwater to surface water. Water discharge planned to POTW.	
Worker and Community Right to Know Act	**Protects workers and community**	**P.L. 1983c.315 P.L. 1985c.543 Executive Order #161**	**Notification of presence of hazardous substances to State Emergency Planning Commissions and to local Emergency Planning Committees.**	**ARAR. Applies to all on-site treatment alternatives.**	
Disposal of Hazardous Waste					
Federal Resource Conservation and Recovery Act	**General Waste Management Practices**	**40 CFR 260**	**Establishes procedures and criteria for modification or revocation of any provision in 40 CFR Part 260-265.**	**ARAR. Establishes general requirements for hazardous waste management.**	
Federal Resource Conservation and Recovery Act	**Identification and Listing of Hazardous Waste**	**40 CFR 261**	**Identifies solid wastes which are subject to regulation as hazardous wastes.**	**ARAR. Generation of a hazardous waste possibly including spent carbon or contaminated soil. Hazardous waste must be handled and disposed of in accordance with RCRA. Chemical testing and characterization of waste required.**	
Federal Resource Conservation and Recovery Act	**Standards Applicable to Generators of Hazardous Waste**	**40 CFR 262**	**Establishes requirements (e.g., EPA ID numbers and manifests) for generators of hazardous waste.**	**ARAR. Waste that is characterized as hazardous.**	
Federal Resource Conservation and Recovery Act	**Standards Applicable to Transporters of Hazardous Waste**	**40 CFR 263**	**Establishes standards which apply to persons transporting manifested hazardous waste within the United States.**	**ARAR. Transport of waste that is characterized as hazardous.**	
Federal Resource Conservation and Recovery Act	**Standards Applicable to Owners and Operators of Treatment, Storage and Disposal Facilities**	**40 CFR 264**	**Establishes the minimum national standards which define acceptable management of hazardous waste.**	**ARAR. Generation and storage of hazardous waste.**	

400106

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
Federal Resource Conservation and Recovery Act	**Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities**	**40 CFR 265**	**Establishes minimum national standards that define the periods of interim status and until certification of final closure or if the facility is subject to post-closure requirements, until post-closure responsibilities are fulfilled.**	**Potential ARAR since remedies should be consistent with the more stringent 40 CFR 264 standards, as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and welfare and the environment.**	
Federal Resource Conservation and Recovery Act	**Land Disposal Restrictions**	**40 CFR 268**	**Identifies hazardous wastes which are restricted from land disposal. All listed and characteristic hazardous waste or soil or debris contaminated by a RCRA hazardous waste and removed from a CERCLA site may not be land disposed until treated as required by LDRs.**	**ARAR. Generated waste will need to meet LDRs for offsite disposal.**	
Federal Resource Conservation and Recovery Act	**Hazardous Waste Permit Program**	**40 CFR 270**	**Establishes provisions covering basic EPA permitting requirements.**	**Potential ARAR. A permit is not required for on-site CERCLA response actions. Substantive requirements are added in 40 CFR 264.**	**Provides the requirements for properly documenting and manifesting hazardous and non-hazardous waste shipments.**
Federal Resource Conservation and Recovery Act	RCRA	40 CFR 265	Establishes organic air emission standards for tanks, surface impoundments, and containers.	ARAR for hazardous waste treatment, storage, and disposal facilities (TSDFs) that receive new or re-issued permits or Class 3 modifications after 5 January 1995.	
Federal Hazardous Material Transportation Act	**Hazardous Materials Transportation Regulations**	**49 CFR 107, 171-177**	**Regulates transportation of hazardous materials.**	**ARAR since response action may involve transportation of hazardous materials.**	**Provides the requirements for properly documenting, manifesting, and packaging hazardous and non-hazardous waste shipments.**
State of New Jersey Statutes and Rules ***General Remediation***	**Hazardous Waste**	**N.J.A.C. 7:26C Hazardous Waste**	**Establishes rules for the operation of hazardous waste facilities in the state of New Jersey.**	**Potential ARAR depending on hazardous waste disposal location.**	**Provides the requirements for storing and handling hazardous waste onsite.**

400107

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and Superfund Amendments and Reauthorization Act of 1986 (SARA)	National Contingency Plan	40 CFR 300, Subpart E	Outlines procedures for remedial actions and for planning and implementing off-site removal actions.	ARAR.	
Federal Occupational Safety and Health Act	Worker Protection	29 CFR 1904	Requirements for worker protection and for recording and reporting occupation injuries and illnesses.	ARAR. Under 40 CFR 300.38, requirements of OSHA apply to all activities which fall under jurisdiction of the National Contingency Plan.	
State of New Jersey Statutes and Rules	Technical Requirements for Site Remediation	N.J.A.C. 7:26E	Established minimum regulatory requirements for investigation and remediation of contaminated sites in New Jersey.	ARAR for all remedial actions.	
State of New Jersey Statutes and Rules	Emergency Response Notice of Release of Hazardous Substance to Atmosphere	NJSA 7:26, 26:2C-19	Control exposure to air pollution by immediate notification to the department hotline of any air release incident.	ARAR for any remedial alternative having the potential to result in an air release.	
State of New Jersey Statutes and Rules	Notification of Spills	NJAC 7:21(E)	Immediate notification of any spill of hazardous substances.	ARAR for remedial alternatives having potential for a spill of a hazardous substance.	
State of New Jersey Statutes and Rules	Restrictions of Noise	NJSA 13:1G-1 et.seq.	Prohibits and restricts noise which unnecessarily degrades the quality of life.	ARAR for all remedial action.	
State of New Jersey Statutes and Rules	Investigation derived waste management	NJDEP's Guidance Document	Provides guidance on the disposition of IDW.	ARAR. To be considered during investigation.	
State of New Jersey Statutes and Rules	Restrictions of Noise	NJAC 7:29-1	Sets maximum limits of sound from any industrial, commercial, public service or community service facility.	ARAR for all remedial actions.	

400108

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
State of New Jersey Statutes and Rules	General Requirements for Permitting Wells	NJAC 7:9-7	Regulates permit procedures, general requirements for drilling and installation of wells, licensing of well driller and pump installer, construction specification, and well casing.	ARAR when installing new wells or if existing wells should require modification.	
State of New Jersey Statutes and Rules	Well Abandonment Procedures	NJAC 7:9-9	General requirements for sealing of all wells (e.g., single cased, multiple cased, hand dug, test wells, boreholes and monitoring wells, abandoned wells).	ARAR if any existing wells need to be abandoned and sealed.	
State of New Jersey Statutes and Rules	Drilling Contractor Requirements	NJSA 58:4A-5 et.seq.	Well drillers licensing, supervision, inspection and sampling.	ARAR when additional wells are installed.	
State of New Jersey Statutes and Rules	Groundwater Monitoring	N.J.A.C. 7:26-9	Groundwater monitoring system requirements.	ARAR for any remedial alternative requiring groundwater monitoring.	
State of New Jersey Statutes and Rules	NJDEP Standards for Soil Erosion and Sediment Control referenced at	N.J.A.C. 2:90	The Hudson-Essex and Passaic Soil Conservation District governs all soil disturbances greater than 5000 ft^2.	ARAR for excavation activity.	A Soil Erosion and Sediment Control Plan is required that will describe the soil erosion controls.
State of New Jersey Statutes and Rules	Construction General Permit (NJG0088323)	N.J.A.C. 7:14A	Administered by the Hudson-Essex and Passaic Soil Conservation District for soil disturbances greater than 5000 ft^2.	ARAR for excavation activity.	Requires the submittal of a Request for Authority to Discharge Stormwater to Surface Water.
Off-Gas Management					
Federal Clean Air Act	National Primary and Secondary Ambient Air Quality Standards	40 CFR 50	Establishes emission limits for six pollutants (SO2, PM10, CO, O3, NO2, and Pb).	Emission of air pollutants may be of concern for some remedial technologies.	These requirements become ARARs if site air emissions exceed the major facility thresholds listed below. This is not expected for the developed alternatives. • Carbon monoxide, particulate matter, Sulfur dioxides >= 100 tons/year • Nitrous Oxides, VOCs, Total HAPs >=25 tons/year • Lead, Any HAP >= 10 tons/year • All other contaminants, except CO2 >= 100 tons/year
Federal Clean Air Act	Standards of Performance for New Stationary Sources	40 CFR 60	Provides emissions requirements for new stationary sources.	ARAR.	
Federal Clean Air Act	National Emission Standards for Hazardous Air Pollutants	40 CFR 61	Provides emission standards for 8 contaminants including benzene and vinyl chloride. Identifies 25 additional contaminants, as having serious health effects but does not provide emission standards for these contaminants.	ARAR.	

400109

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
State of New Jersey Statutes and Rules	Standards for Hazardous Air Pollutants	N.J.A.C. 7:27 Air Pollution Control	Rule that governs the emitting of, and such activities that result in, the introduction of contaminants into the ambient atmosphere.	ARAR.	NJAC 7:27- 8 establishes permit conditions for minor facilities. The air emissions thresholds below which there are no permitting and air emission controls requirements are identified in N.J.A.C. 7:27-8, Tables A and B.
State of New Jersey Statutes and Rules	Permitting Conditions for air pollution control	N.J.A.C. 7:27-8	Establishes permit conditions for air pollution control apparatus, for minor facilities.	ARAR if remedial action includes a technology that would result in air emissions.	
		N.J.A.C. 7:27-22	Establishes permit conditions for air pollution control apparatus, for major facilities, and facilities with operating permits.		NJAC 7:27-22 establishes permit conditions for major facilities. Emissions from the early action are expected to be below these thresholds although confirmatory calculations will be performed during the design phase.
State of New Jersey Statutes and Rules	Permitting Conditions for air pollution control	N.J.A.C. 7:27-11 and 17	Controls and prohibits air pollution, particle emissions, and toxic VOC emissions.	ARAR if remedial action includes a technology that would result in air emissions.	If emissions exceed the established reporting thresholds for minor facilities, then the operation of the alternative must be permitted under N.J.A.C. 7:27-8. If the emissions further exceed the established SOTA threshold values, then emission controls would be required. To determine if an air permit and emissions controls are required for each remedial alternative, the maximum potential emissions must be estimated and compared to the total and individual contaminants thresholds (reporting and SOTA) in Tables A and B. If the emissions are below the reporting thresholds, then a Request for Determination containing the estimated emissions would be submitted to the NJDEP to confirm that a permit is not required. If the emissions are above the reporting thresholds, then a permit application must be submitted and the permit would

400110

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
					establish the monitoring requirements as well as needed emission controls for emissions greater than the SOTA thresholds. Of note, combustion equipment less than 1 MM Btu is not required to be permitted but must be noted in the Request for Determination. For equipment greater or equal to 1 MM Btu, the emissions must be estimated and included in the air permit application, which will specify administrative as well as emission controls for emissions above the SOTA thresholds. Also of note, the emissions during excavation and from the soil washing operation must also be estimated and included in the Request of Determination if found to be below the reporting thresholds or in the permit application if estimated to be above these thresholds. The air pollution control regulations do not include specific monitoring requirements; the permit would establish the monitoring requirements. It is reasonable to expect that monitoring frequency will be related to the total emissions from the early action and how close they are to the reporting thresholds. During the pilot test for air sparging conducted during the focused Phase 2 RI, it was determined that the emissions from the test were below the reporting thresholds. Operation of the biocell will involve low

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
					injection rate of air sufficient only to maintain aerobic conditions. Back of the envelope calculations are performed in this FFS to determine where these emissions fall relative to the established thresholds. These calculations will be verified during the design when detailed emission calculations will be performed and the request for determination or a permit application (as applicable) would be prepared and submitted to the NJDEP. During the design, detailed emission calculations will also be performed for other components of the remedial alternatives that may release VOCs in order to determine the need for a permit and emission controls.
State of New Jersey Statutes and Rules	Incineration Requirements	N.J.A.C. 7:26-10	Specifies maximum air contaminant emissions rates, testing requirements, and minimum design standards.	ARAR if remedial alternative includes incineration.	
State of New Jersey Statutes and Rules	Incineration Requirements	N.J.A.C. 7:26-11	Specifies maximum air containment emission rates, testing requirement, and minimum design standards during interim status.	ARAR if remedial alternative includes incineration.	
State of New Jersey Statutes and Rules	Incinerator Permitting	N.J.A.C. 7:26-12	Delineates the information needs to be submitted in Part A and B of the permit application.	ARAR if remedial alternative includes incineration.	

400112

Table 2-3 Potential Location-Specific Applicable or Relevant and Appropriate Requirements
Diamond Head Oil Superfund Site, Kearny, New Jersey

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
Executive Order Floodplain Management	**Floodplain Management**	**Exec. Order No. 11988 40 CFR 2 6:302(b) and Appendix A**	**Requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the maximum extent possible, the adverse impacts associated with direct and indirect development of a floodplain.**	**ARAR if remedial activities take place in or near a 100-year or 500-year floodplain.**	**A section of the Northern portion of the site is within the 500-year floodplain. If the RTA falls within this area, applicable requirements will be met.**
Federal Flood Plains Regulatory Requirements	Regulatory Requirements	(RCRA Location Standards (40 CFR 264.18)	This regulation outlines the requirements for constructing a RCRA facility on a 100-year flood plain.	ARAR if remedial alternatives include construction in or near a 100-year floodplain.	It is expected that the onsite biocell would not be considered a RCRA treatment facility.
National Wildlife System	Protects national wildlife	16 U.S.C. 668 50 CFR 27	Restricts activities within a National Wildlife Refuge.	Not an ARAR since site is not a wildlife refuge.	
Wild and Scenic Rivers Act	Prohibits adverse effects on scenic rivers.	16 U.S.C. 1274 40 CFR 6:302	Prohibits adverse effects on scenic rivers.	Not an ARAR since site is not on a river.	
Clean Water Act	**Prohibits discharge of dredged or fill material into wetlands**	**33 U.S.C. 1251 Section 404, 40 CFR 230, 231**	**Prohibits discharge of dredged or fill material into wetlands without a permit. Preserves and enhances wetlands.**	**ARAR for remedial alternatives which involve disturbance to wetlands.**	**The RTA encompasses a significant portion of the delineated wetland areas at the site. This FFS assumes that wetland areas that are remediated will be created at a different location by the owner of the Diamond Head property. Wetland restoration is not included in the FFS and if it will not be undertaken at a different site by the property owner, may be required and will become part of the final remedy for the site.**
Policy Floodplains/Wetlands Assessment	**Floodplain assessment**	**EPA 1985 Statement**	**Provides federal policy for the assessment of floodplains and wetlands**	**ARAR for remedial alternatives that affect wetlands and floodplains.**	**Same as above**
Endangered Species Act	Protects endangered species	16 U.S.C. 1531	Restricts activities where endangered species may be present.	ARAR if endangered species are observed at the site during ecological site assessments.	No threatened or endangered species have been identified within the property boundaries of the Diamond Head site.

400113

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
National Historic Preservation Act	Protects historic places	16 U.S.C. 470	Requires federal agencies to take into account the effect of any federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in or is eligible for inclusion in the National Register of Historic Places.	Not an ARAR since there are no areas that are included or eligible for inclusion in the National Register of Historic Places.	
Historic Sites, Buildings and Antiquities Act	Protects national landmarks	16 U.S.C. ss 461-457	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	Not an ARAR since there are no areas that are included or eligible for inclusion in the National Register of Historic Places.	
U.S. Army Corps of Engineers Nationwide Permit Program	**Army Corp. of Engineers Permit Program**	**33 CFR 330**	**Prohibits activity that adversely affects a wetland if a practical alternative that has less effect is available.**	**ARAR for remedial alternatives which have the potential to affect wetlands.**	**Please refer to comment above on approach to wetland restoration assumed in this FFS.**
Rivers and Harbors Act of 1899	Army Corp. of Engineers Permit Program	33 CFR 320-330	Establishes a permit program for dams, dikes, dredging, and other construction in navigable waters of the U.S.	Not an ARAR since site is not located within area covered by regulation.	
Executive Order Protecting Wetlands	**Protection of Wetlands**	**Executive Order No. 11990**	**Requires Federal agencies to minimize the destruction, loss, or degradation of all wetlands affected by Federal activities.**	**ARAR for remedial alternatives which have the potential to affect wetlands.**	**Please refer to comment above on approach to wetland restoration assumed in this FFS.**
Fish and Wildlife Coordination Act	Requires approval for modification of water body	16 U.S.C. 661 40 CFR 2 6:302(g)	Requires consultation with the U.S. Fish and Wildlife Services when a Federal department or agency proposes or authorizes any modification of any stream or other water body, and adequate provision for protection of fish and wildlife resources.	ARAR if action is covered by regulation.	
National Ambient Air Quality Standards (NAAQS)	Air Quality Standards	40 CFR 50	Establishes non-attainment zones with respect to health-based criteria.	ARAR for remedial activities which emit restricted contaminants into the atmosphere.	This becomes an ARAR if the remedial activity meets the thresholds for major facilities.
Federal Endangered and Non-Game	Protection of threatened and endangered species	N.J.S.A. 23:2A-1	Standards for the protection of threatened and endangered species.	ARAR if any species exist at the site.	No threatened or endangered species have been identified within the property boundaries of the Diamond Head site.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
Species Act					
Flood Hazard Area Regulations	**Protection of floodplains**	**N.J.A.C. 7:13**	**Protects floodplains through permitting requirements for construction and development activities**	**ARAR if remedial activities are located in or near a 100- or 500-year floodplain.**	**A section of the Northern portion of the site is within the 500-year floodplain. If the RTA falls within this area, applicable requirements will be met.**
Flood Hazard Area Control Act	**Delineates flood hazard areas**	**N.J.S.A. 58: 16A-50**	**Delineates flood hazard areas and regulates use.**	**ARAR if remedial activities are in or near a 100- or 500-year floodplain.**	**A section of the Northern portion of the site is within the 500-year floodplain. If the RTA falls within this area, applicable requirements will be met.**
Wetland Act of 1970	**Establishes wetland regulated activities**	**N.J.S.A. 13:9A-1 et.seq.**	**Establishes listing and permitting requirements for regulated activities**	**ARAR. Establishes listing and permitting requirements for regulated activities**	**Please refer to comment above on approach to wetland restoration assumed in this FFS.**
Freshwater Wetlands Protection Act	**Establishes freshwater wetlands regulated activities**	**N.J.S.A. 13:9B**	**Establishes listings and permitting requirements for regulated activities in state freshwater wetlands**	**Potential ARAR. Establishes listings and permitting requirements for regulated activities in state freshwater wetlands**	**Please refer to comment above on approach to wetland restoration assumed in this FFS.**
Open Lands Management	Considers recreational projects during remediation	N.J.A.C. 7:2-12.1 et.seq.	Considers impact of remedial actions on recreational projects funded by Open Lands Management Grants.	Not an ARAR for remedial actions on recreational projects funded by Open Lands Management Grants.	
Natural Areas System	Protects natural area sites	N.J.A.C. 7:2-11	Protects natural area sites listed under the Natural Areas Register.	Not an ARAR since site is not listed on the Natural Areas Register.	
State Trails System	Protects state trails	N.J.S.A. 13:8-30 et. seq.	Requires that use of trail does not interfere with nature; maintains natural and scenic qualities.	Not an ARAR since site does not have trails.	
New Jersey Wild and Scenic Rivers System	Protects Scenic River systems	N.J.S.A. 13:8-45 et. seq.	Governs component river area, flood hazard area, or part of state park, wildlife refuge or similar area.	Not an ARAR since site is not component river area, flood hazard area, or part of state park, wildlife refuge or similar area.	
New Jersey Threatened Plant Species	Lists threatened plant species.	New Jersey's Threatened Plan Species	Lists threatened plant species.	ARAR if remedial actions impact threatened plant species.	No threatened or endangered species have been identified within the property boundaries of the Diamond Head site.

400115

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability	Comments
Endangered Plant/Animal Species Habitats	Lists threatened habitats where endangered species occur.	New Jersey's Endangered Species Act	Lists threatened habitats where endangered species occur.	ARAR if remedial actions impact endangered species.	No threatened or endangered species have been identified within the property boundaries of the Diamond Head site.

400116

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness: Residual LNAPL	Effectiveness: COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
No Action	No Further Action	None	No action.					Required by NCP for comparison with other alternatives; does not meet RAOs.
Monitoring	Monitoring	Measuring LNAPL thickness Groundwater sampling	Monitor the effectiveness of the chosen Early Action over the course of time.	High	Low	Low	Low	Does not meet RAOs when implemented alone; is applicable and effective in conjunction with other technologies.
Institutional Controls	*Institutional Controls*	*Land use restrictions*	*Restrict access to LNAPL-contaminated soils through local ordinances, building permits, restrictive covenants on property deeds (Deed Notice) and state registries of contaminated sites.*	*Moderate*	*Low*	*Low*	*Low*	*Does not meet RAOs when implemented alone; may be applicable in conjunction with other technologies.*
	Groundwater Use Restrictions	*Access restrictions to groundwater and LNAPL*	*Establish a Classification Exception Area (CEA) for the area impacted by LNAPL, which will impose restrictions on groundwater use.*	*Moderate*	*Low*	*Low*	*Low to moderate*	*Since this is an Early Action, the applicability of groundwater use restrictions would need to be determined as part of an overall remedy for the site. Therefore, not retained for further consideration.*

400117

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
Monitored Natural Attenuation (MNA)	*Monitored Natural Attenuation*	*Monitored natural attenuation of groundwater*	*Use of naturally occurring physical, chemical and biological processes such as dissolution, biodegradation and volatilization to reduce LNAPL concentrations.*	*High*	*Low*	*Low*	*Moderate*	*Based on NJAC 7:26E-6.1(d), "...natural remediation of free and/or residual product will not be allowed." Technically infeasible for the LNAPL at the site as demonstrated by its continuing presence. Does not meet RAOs.*
Containment	Passive Hydraulic Controls	Slurry or sheet-pile wall	Physical barrier to groundwater migration.	Moderate to High	Low	Low	Low to Moderate	Does not meet the RAO by itself. LNAPL is essentially immobile and therefore containment technologies would not provide added effectiveness. However, may need to be applied if excavation with dewatering is needed in order to control the flow of groundwater into the excavated area.
	Vertical Subsurface Barriers	*Grout curtain*	*Create subsurface barrier to horizontal GW flow by grout injection.*	*Moderate*	*Low*	*Low*	*Moderate*	*Does not meet the RAO. LNAPL is essentially immobile and therefore containment technologies would not provide added effectiveness.*
	Surface Controls	*Grading*	*Reshape topography to control infiltration, runoff, and erosion.*	*High*	*Low*	*Low*	*Low*	*Does not meet the RAO. Not effective unless used in conjunction with other technologies.*
		Revegetation	*Add topsoil, seed and fertilize to establish vegetation (to control erosion and reduce infiltration).*	*High*	*Low*	*Low*	*Low*	*Does not meet the RAO. Not effective unless used in conjunction with other technologies.*

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness: Residual LNAPL	Effectiveness: COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
	Horizontal Subsurface Barriers	*Block displacement*	*Encapsulate block of soil with grout in conjunction with vertical barriers.*	*Moderate*	*Low*	*Low*	*Moderate to High*	*Does not meet the RAO. LNAPL is essentially immobile and therefore containment technologies would not provide added effectiveness.*
	Cover	*Soil*	*Place clay over contaminated soils.*	*High*	*Low*	*Low*	*Moderate*	*Does not meet the RAO. LNAPL is essentially immobile and significantly submerged below the water table and therefore containment technologies would not provide added effectiveness.*
		Multi-layer	*Cap includes a 2 foot thick clay layer and an impermeable geomembrane liner. In addition, a drainage layer and freeze-thaw protective layer are included in cap.*	*Moderate*	*Low*	*Low*	*High*	*Does not meet the RAO. LNAPL is essentially immobile and significantly submerged below the water table and therefore containment technologies would not provide added effectiveness.*
		Asphalt	*Place asphalt or concrete over contaminated soils.*	*Moderate*	*Low*	*Low*	*Moderate*	*Does not meet the RAO. LNAPL is essentially immobile and significantly submerged below the water table and therefore containment technologies would not provide added effectiveness.*
In Situ Treatment	Physical/ Chemical	*In Situ chemical oxidation (ISCO)*	*Degrade contaminants by chemical oxidation. Typical oxidants include ozone, hydrogen peroxide, permanganate, and persulfate.*	*Low, highly dependent on the quantity requiring oxidation*	*Moderate to high*	*Low*	*High*	*This technology would be difficult to implement and is expected to be cost-prohibitive. The quantity of reagent required to oxidize LNAPL in Situ would be difficult to inject and cost-prohibitive; multiple applications may be required. This technology is unproven for large LNAPL sites. It is therefore screened from further consideration.*

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness: Residual LNAPL	Effectiveness: COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
		Stabilization / Solidification	*Immobilize contam-inants using solidifi-cation agents.*	*High*	*Moderate*	*Moderate*	*High*	*This technology may meet the RAO. This technology would be effective to treat some classes of chemical contaminants associated with the LNAPL - metals. However, application of this technology may prohibit access to the contaminated media for future remedial investigation/remedial actions because of the addition of stabilizing agents and is therefore screened from further consideration.*
		Shallow soil mixing	*Mixing of soil in-place using large augers to mix in treatment amendments and reduce LNAPL concentrations.*	*High*	*Low*	*Low*	*High*	*Feasible treatment delivery method for treatment technologies for residual LNAPL and other COPCs if soil treatment amendments are added In Situ. Will not meet RAO by itself and therefore would be retained only to compliment other technologies.*
		Air sparging	*Inject air into groundwater to volatilize and enhance aerobic biodegradation of amenable contaminants. This is often combined with the use of SVE to capture the air.*	*Low to moderate*	*Low to moderate*	*Low*	*Moderate to high*	*This technology is not expected to meet the RAO. It is not expected to be effective for the significant quantities of highly LNAPL-saturated soil and it will be difficult to implement given the subsurface heterogeneity at the site. It is therefore screened from further consideration.*

400120

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Soil vapor extraction (SVE)	*Extract vapor from the subsurface and remove contaminants via the vapor stream through desorption and volatilization mechanisms.*	*Low*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO and can not be implemented given the shallow depth to water and largely submerged LNAPL at this site. This technology is not expected to be effective for the significant quantities of highly LNAPL-saturated soil and it will be difficult to implement given the subsurface heterogeneity at the site. It is therefore screened from further consideration.*
		Washing / Flushing	*Wash or flush soil with water, surfactant, or co-solvent.*	*Moderate*	*Low*	*Moderate*	*High*	*This technology is not expected to meet the RAO as it will not be effective in highly heterogeneous settings with highly viscous LNAPL. This technology is not expected to significantly reduce the volume of LNAPL, It is therefore screened from further consideration.*
		Vitrification	*Melt/solidify soil matrix using electric currents.*	*Low*	*Moderate*	*High*	*High*	*This technology would meet the RAO, but would prevent access for future investigation/remediation efforts. There are limited commercial applications, and it is a very costly technology relative to other technologies. It is therefore screened from further consideration.*
		Pneumatic fracturing	*Fracturing of the consolidated formation to increase permeability and thus increasing effectiveness of In Situ treatment.*	*Low*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. Early Action is focused on shallow LNAPL contamination and fracturing is not feasible at this shallow setting.*

400121

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
	Biological	Enhanced bioremediation	Degrade contaminants through aerobic or anaerobic processes by stimulating biological growth through addition of an organic substrate and/or nutrients.	Moderate	Moderate	Moderate	Moderate	This technology may meet the RAO. It can be applied via bio sparging (supplemented by the application of bacteria) or by combining bio sparging with the In Situ mixing of nutrients. Difficult to implement in highly heterogeneous setting and may require some removal of debris from the target area. As some classes of contaminants will not be addressed (e.g., metals, PCBs, pesticides), the technology will require revisiting areas after completion of the Early Action to treat for these contaminants.
		Phytoremediation	*Phytoremediation uses plants and microbes associated with the plant root system to stabilize, degrade, or extract contaminants from the soil and groundwater by either adsorption or absorption.*	*High*	*Low*	*Moderate*	*Low*	*This technology is not expected to meet the RAO. Not effective for LNAPL-saturated soil. It is therefore screened from further consideration.*

400122

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness: Residual LNAPL	Effectiveness: COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
		Biosparging	Biologically degrade organics through stimulation of aerobic organisms by the addition of oxygen. Typically conducted using low air flow rates so there is no need for vapor capture.	Moderate	Low to moderate	Moderate	Low to Moderate	This technology may meet the RAO but would require significant time. Difficult to implement in highly heterogeneous setting and may require some removal of debris from the target area. As some classes of contaminants will not be addressed (e.g., metals, PCBs, pesticides), the technology will require revisiting areas after completion of the Early Action to treat for these contaminants.
	Thermal	*Hot air or steam stripping*	*Inject hot air or steam/ to vaporize volatile and semi-volatile contaminants and recover the vapors.*	*Low, difficult to implement with shallow vadose zone*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. This technology is difficult to implement; it would result in the production of steam and vapors that would be difficult to collect given the shallow depth to water. This technology is less implementable than other In Situ thermal technologies and is therefore screened from further consideration.*
		Conductive heating	*Application of conductive heat to the subsurface to increase soil temperature, decrease the viscosity of the LNAPL, and increase its mobility. Heat can be controlled to stay below temperatures that would create offgas.*	*Moderate*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. This technology will slightly reduce the viscosity of the LNAPL but the degree of reduction expected would not increase its mobility and recoverability.*

400123

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness: Residual LNAPL	Effectiveness: COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
		Electric resistance heating	*Application of an electrical current through the soil to increase soil temperature, decrease the viscosity of the LNAPL, and increase its mobility. Electrical current can be controlled to keep soil below temperatures that would create offgas.*	*Low to Moderate*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. This technology will slightly reduce the viscosity of the LNAPL but the degree of reduction expected would not increase its mobility and recoverability.*
		Radio frequency heating	*Use network of Radio Frequency Transmit-ters to heat soil; vaporize volatile and semi-volatile compounds, and collect them with a vapor extraction system.*	*Low*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. This technology is expected to have limited effectiveness for residual LNAPL treatment. Difficult to implement due to the collection of vapors required and limited vadose zone available at the site. Other more implementable In Situ thermal options are available.*

400124

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
Fluid Collection, Treatment, Discharge, Disposal	*Collection - LNAPL extraction*	*Recovery trench*	*Trenches within areas of mobile LNAPL are installed and backfilled with low-permeability material such as pea gravel. LNAPL preferentially flows into the low-permeability material and collects in sumps for extraction.*	*High*	*Low*	*Low*	*Moderate*	*This technology cannot be used to recover LNAPL because of its high viscosity and low mobility. This technology is not needed to support the retained In Situ or Ex Situ treatment technologies.*
		Recovery wells	*Large-diameter boreholes are installed with extraction wells and sumps. The boreholes are backfilled with low-permeability material.*	*High*	*Low*	*Low*	*Moderate*	*This technology cannot be used to recover LNAPL because of its high viscosity and low mobility. This technology is not needed to support the retained In Situ or Ex Situ treatment technologies.*
	Collection - Multi Phase Extraction	*Multi phase extraction*	*Simultaneous extraction of LNAPL, groundwater, and soil gas*	*Moderate*	*Low*	*Low*	*Moderate to High*	*This technology would have to be implemented in areas with high LNAPL mobility, and therefore combined with other In Situ technologies. Would result in extraction of water and some vapor which would require treatment. Screened from further consideration due to immobile nature of LNAPL and availability of simpler collection technologies.*

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

					Effectiveness			
General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
Fluid Collection, Treatment, Discharge, Disposal	Treatment - Physical-Chemical	Oil/water separation	Phase separation process to remove LNAPL from water stream	High	High	Low	Low	This technology can be used Ex Situ to separate LNAPL recovered from water from dewatering operations needed to support alternative implementation.
		Air stripping	Phase separation from dissolved-phase to vapor-phase by forced air	High	Low	Moderate	Low	This technology can be used Ex Situ to treat groundwater recovered during remedial activities prior to discharge.
		Steam stripping	Phase separation by steam and forced air	High	High	Moderate	Moderate to high	This technology can be used Ex Situ to treat groundwater recovered during remedial activities prior to discharge. While this technology can be applied, it is more difficult to implement and more costly than other available technologies. If physical-chemical treatment of water is required, a representative process option will be retained.
		Adsorption	Contaminants are removed from the waster stream by adsorption with Granular Activated Carbon or other adsorptive media such as activated clay	High	Moderate	Moderate	Moderate	This technology can be used Ex Situ to treat groundwater recovered during remedial activities prior to discharge.
		Precipitation	Chemical flocculants are added to precipitate metals from solution	Moderate	Low	Moderate	High	This technology can be used Ex Situ to treat groundwater recovered during remedial activities prior to discharge.

400126

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness: Residual LNAPL	Effectiveness: COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
		Advanced oxidation	*Chemical, photo, or other oxidation process whereby organic contaminants are converted to carbon dioxide and water*	*Low*	*High*	*Moderate*	*High*	*This technology can be used Ex Situ to treat groundwater recovered during dewatering operations needed to support alternative implementation. Typically more difficult to implement and more costly than other available technologies with similar effectiveness, therefore screened from further consideration.*
Fluid Collection, Treatment, Discharge, Disposal	Discharge	Groundwater discharged to: *Surface water* POTW	Includes various options for the discharge of treated groundwater.	Moderate	Low	Low	Low	Provides for the disposal of the treated groundwater recovered during dewatering operations in support of alternative implementation. *Surface water discharge was not retained.* POTW discharge was retained.
Fluid Collection, Treatment, Discharge, Disposal	Disposal	LNAPL disposal to: Offsite Treatment Storage and Disposal Facility (TSDF)	Disposal of extracted LNAPL at an offsite TSDF.	High	Low	Low	Low	Provides for the disposal of the LNAPL recovered from water from dewatering operations needed to support alternative implementation
Vapor Treatment, Discharge	Physical Treatment	Adsorption	Adsorption of contaminants in emissions from the treatment system	High	High	Moderate	Moderate	This technology is effective in removing VOCs from vapor emissions from other treatment technologies (such as air stripper off gas, thermal desorption off gas, etc.) where VOC concentrations are not highly concentrated.

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness: Residual LNAPL	Effectiveness: COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
		Catalytic oxidizer	Treatment of the contaminants in the emissions from the treatment system via catalytic oxidation	Moderate	High	Moderate	High	This technology can be used to treat high concentrations of VOCs in vapor. Requires supplemental fuel supply (either electric or natural gas) to heat air. Vapor emissions will likely not be high enough to warrant this technology, therefore, it is screened from further consideration.
	Discharge	Discharge to ambient air		Moderate	High	High	Low	Provides for the discharge of vapor to ambient air. Depending on ARARs, may need to be combined with vapor treatment technologies in order to meet discharge limits.
Excavation, Treatment, Disposal	Excavation of Soils	Backhoe / Excavation	Physically remove shallow soils.	Moderate	High	High	High	This technology may support either removal the LNAPL-contaminated soil for Ex Situ treatment or offsite disposal or the construction of an In Situ treatment technology. The end result will depend on the type of treatment and disposal with which excavation is combined. Excavation is technically feasible to depths of about 20 feet. However, the shallow depth to water at this site would require construction dewatering during excavation, and this water would need to be treated and discharged. This technology may also treat or remove from the site other classes of chemical contaminants present in the soil.

400128

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
Excavation, Treatment, Disposal	Treatment - Physical/ Chemical	Stabilization	Immobilize free product and contaminants through addition of stabilization agents to prepare material for transport and disposal.	Moderate	High	High	High	This technology would be effective to stabilize LNAPL Ex Situ and prepare the material for off site transport and disposal.
		Ex Situ soil washing	Surfactants, co-solvents, and/or acidic/basic solutions are used to cleanse soil and desorb and dissolve contaminants including residual LNAPL and other COPCs. Soil is processed in an on-site slurry reactor and water treatment facility. Soil can then be replaced onsite for disposal after LDRs are met.	Low to moderate	High	Moderate to High	High	This Ex Situ technology, combined with excavation, would meet the RAO and treat the LNAPL and associated classes of chemical contaminants to varying degree. This technology would be difficult to implement and require significant infrastructure for storage, application, and disposal or management of washing solutions.
	Treatment - Biological	*Ex Situ bioremediation*	*Enhance naturally occurring aerobic biological processes by homogenizing excavated soil, placing in an area, and adding oxygen or other substrates.*	*Low*	*Moderate*	*Moderate*	*Moderate*	*This Ex Situ technology would meet the RAO. However, given the volume of material requiring treatment, its implementation at this site would require significantly longer than its In Situ counterpart. It is therefore not retained for further consideration.*

400129

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implemen-tability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
	Treatment - Thermal	*Low-temperature thermal desorption*	*Processing soil through thermal treatment unit desorbs contaminants from soil and removes them in the off-gas, which also may require treatment.*	*Low*	*Low*	*Moderate*	*High*	*This technology is not expected to meet the RAO due to the nature of the LNAPL material*
		Onsite incineration	*Combust soils at high temperature.*	*Low*	*Moderate*	*Moderate*	*High*	*This technology would be moderately effective for Ex Situ treatment of LNAPL as well as most other classes of chemical contaminants present in the soil. However, it is significantly more costly that other ex-situ treatment methods, would require vapor treatment and permitting, and is therefore screened from further consideration.*
		Plasma	*Expose soils to super-heated plasma.*	*Low*	*High*	*High*	*High*	*Extensive treatability testing required; costs similar to incineration; unproven technology.*
		Infrared	*Decompose contaminants with infrared radiation.*	*Low,* *Unproven technology*	*Moderate to High*	*Moderate*	*High*	*Extensive treatability testing required; costs similar to incineration; unproven technology.*
		Wet air oxidation	*Use high temperature and pressure to thermally oxidize contaminants.*	*Low*	*Moderate to High*	*Moderate*	*High*	*Extensive treatability testing required; not cost competitive; unproven technology.*
		Offsite incineration	*Combust soils in offsite commercial incinerator.*	*High*	*Moderate to High*	*High*	*High*	*This technology may meet the RAO but would not be cost competitive.*

400130

TABLE 3-1

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness: Residual LNAPL	Effectiveness: COPCs in Subsurface Soil (A) OR Other Treated Media (B)	Capital and O&M Cost	Screening Comments
Excavation, Treatment, Disposal	*Disposal - Asphalt batching*	*Offsite asphalt plant*	*Incorporation of recovered LNAPL into asphalt material for reuse in paving applications.*	*High.*	*Moderate*	*Moderate*	*Low*	*Exposures to waste re-used from a Superfund site would be a concern. The physical and chemical characteristics of the recovered LNAPL may not be appropriate for asphalt batching and the quantity is not expected to be significant as LNAPL will be recovered only from water from the dewatering operations.*
	Disposal - Offsite	RCRA Subtitle C or Subtitle D landfill	Remove excavated material from site for disposal in RCRA Subtitle C or D permitted TSDF.	Low	High	High	High	This technology will meet the RAO to remove the excavated material from the site through offsite disposal. Soils are likely below any hazardous waste characterization limits and can be disposed in a Subtitle D Landfill. However soils will be tested and any soils failing TCLP limits will require disposal in Subtitle C landfill.
	Disposal - Onsite	Onsite placement of treated soil	Place material onsite after treatment.	High	High	High	Low	This technology is retained because, combined with excavation and treatment, it may meet the RAO to treat residual LNAPL. Soils can be treated and placed onsite. Classes of contaminants that were not addressed through the treatment will require revisiting areas for subsequent treatment. The contaminants that will require addressing will depend on the preceding treatment method.

400131

<table>
<tr><td colspan="9">TABLE 3-1</td></tr>
<tr><td colspan="9">TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION</td></tr>
<tr><td colspan="9">DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY</td></tr>
<tr><th rowspan="2">General Response Action</th><th rowspan="2">Remedial Technologies</th><th rowspan="2">Process Options</th><th rowspan="2">Description</th><th rowspan="2">Technical Implemen-tability</th><th colspan="2">Effectiveness</th><th rowspan="2">Capital and O&M Cost</th><th rowspan="2">Screening Comments</th></tr>
<tr><th>Residual LNAPL</th><th>COPCs in Subsurface Soil (A) OR Other Treated Media (B)</th></tr>
<tr><td colspan="9">Note: Remedial technologies are screened for Implementability, Effectiveness, and Cost based on criteria rankings of “Low”, “Moderate”, and “High”. Effectiveness is assessed relative to the effectiveness to meet the RAO for this LNAPL Early Action. A high assessment for costs means that the cost of this technology / process options is high compared to others considered.
Remedial technologies in blue italics have been screened from further consideration because they prohibit access to contaminated media for future remedial investigation/remedial actions.
Remedial technologies in red italics have been screened from further consideration based on the screening criteria and whether the technology would meet the RAOs.
Remedial technologies in bold have been retained for inclusion in remedial alternatives.
SVE – soil vapor extraction
ISCO – in-situ chemical oxidation
LNAPL – light non-aqueous phase liquid
NA – not applicable
A – Other COPCs in subsurface soil are listed in Table 4. B- Examples of other media to be treated are groundwater and air emissions from considered systems.</td></tr>
</table>

400132

Table 3-2
Summary of Assembled Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny, New Jersey

Alternative Number	**1**	**2**	**3**	**4**
Components	**No Action**	**Construction and Operation of Onsite Biocell**	**Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soils**	**Excavation and Offsite Disposal**
Estimated Time to Achieve PRGs	Unknown	Construction-less than 1 year; Operation-3 to 8 years	1 year	8 months
No Action	X			
Monitoring				
Verification sampling		X	X	X
5-year reviews (1)	X	X		
Containment				
Install sheet piles to minimize infiltration during excavation		X	X	X
Remove sheet pile following remedial action		X	X	
Maintain sheet pile following remedial action				X
In Situ Treatment - Onsite Biocell				
Pre-design investigation		X		
Design activities		X		
Construct biocell		X		
Augment soil with nutrients and bulking agents and place back in cell		X		
Operate and maintain: Maintain cover Operate blowers to maintain aerobic conditions and apply nutrients Treat and discharge of water accumulated in biocell		X		
Fluild Collection, Treatment, and Discharge				
Treat water from dewatering and soil washing by: Oil/water separation TSS removal (assumed that all other contaminants can be discharged to POTW)		X	X	X
Dispose water from dewatering and soil washing				
LNAPL - Transport, dispose at offsite TSDF		X	X	X
Treated water – dispose to POTW (requires construction of sewer connection)		X	X	X
Excavation, Treatment, and Disposal				
Pre-design investigation for waste characterization		X	X	X
Design activities		X	X	X
Excavation				
Excavate soils within areas with measureable LNAPL thickness in wells (2)		X	X	X
Excavate soils within remaining RTA		X	X	X
Treat excavated soils				
Treat soils within areas with measureable LNAPL thickness in wells with stabilization		X	X	X
Treat soils within remaining RTA with stabilization				X
Treat soils within remaining RTA with soil washing			X	
Dispose of excavated soils				
Backfill onsite treated soils		X	X	
Transport and dispose offsite soils within areas with measureable LNAPL thickness		X	X	X
Transport and dispose offsite soils within remaining				X

Table 3-2
Summary of Assembled Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny, New Jersey

Alternative Number	1	2	3	4
Components	No Action	Construction and Operation of Onsite Biocell	Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soils	Excavation and Offsite Disposal
RTA				

(1) One five-year review is included for the biocell as this alternative is expected to not achieve the RAOs and PRG at the end of the construction period. 5-year reviews are also included for the No Action alternative. The soil washing and offsite disposal alternatives are expected to achieve the RAOs and PRG at the end of the construction period and therefore, 5-year reviews are not included.

(2) This component may change during the design but is included as potentially representative of highest costs, final determination will be made during the design.

Table 3-3
Detailed Components of Assembled Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

Alternative Number	Description/Components
1	**<u>No Action</u>** As required by the NCP, the no action alternative is retained for comparison with all other alternatives. This alternative includes no action, no monitoring, and would not achieve established RAOs and PRGs. Five-year reviews are included for 30 years.
2	**<u>Construction and Operation of Onsite Biocell</u>** This alternative includes the following components: <u>Pre-Design Investigation</u> • Conduct an investigation to refine extent of RTA boundaries to within a smaller tolerance (such as ±10 feet) for detailed design purposes. Investigation will focus on use of sampling and analytical techniques prescribed to measure PRGs (see Section 2). • Conduct pre-design investigation for waste characterization purposes to characterize soil and concrete for disposal/recycling purposes. • Test pit and sample soil berm to determine if existing soil can be reused to replace removed berm at end of remedial activities. <u>Remedial Design</u> • Complete full-scale system design and procure subcontractors for its installation; coordinate with various entities (for example, POTW PVSC and NJDEP). • Perform treatability bench/pilot-scale testing to determine most effective operating parameters (including air flow rates, nutrient types, and doses) and verify contaminant treatment efficiency. <u>Pre-Remediation Site Work</u> • Clear vegetation east and north of RTA to accommodate operations, locate facilities, and construct temporary access roads. Estimated area 480,000 SF. • Construct sewer connection from proposed onsite location of modular treatment system to KMUA/PVSC sewer system at intersection of Harrison and Bergen avenues. Estimated sewer length 750 feet, 8–inch-diameter pipe. • Create onsite water source by connecting to 24-inch water main located on southern side of Harrison Avenue. Estimated pipe length 400 feet, 2-inch-diameter pipe. • Construct temporary access roads, turnaround area, and lay-down area (assumed 6 inches of gravel) to support onsite construction vehicles and remedial facilities. Estimated area 67,100 SF. • Install isolation sheet pile wall around entire RTA and between cells. Estimated length 3,700 feet to depth of 35 feet bgs. Install sheet pile wall around perimeter of two areas where LNAPL is found in monitoring wells. Estimated length 600 feet to depth of 35 feet bgs. Estimated total length 4,300 feet. <u>Soil Excavation</u> • Excavate and stockpile 24,000 SF of the approximately 10-foot-high soil berm over area of RTA, and stage onsite in stockpiles. Estimated volume 8,900 CY. • Excavate concrete foundations within RTA. Concrete foundations assumed to cover approximately 100 feet by 50 feet with an assumed thickness of 24 inches. Also assumed 500 CY of miscellaneous concrete debris in northern triangular RTA. Estimated volume 900 CY. • Excavate soil within two areas containing measureable LNAPL thickness in wells. Estimated 10,000 SF to average depth of 7 feet bgs. Estimated volume 2,600 CY. • Excavate and stockpile soil within remainder of RTA. Estimated 166,800 SF to average depth of 7 feet bgs. Estimated volume 42,400 CY. • Excavation to proceed sequentially in six cells, approximately 30,000 SF each, covering entire RTA. Within each cell, work to proceed in small sections (excavate, stockpile, build cell, and place back) to minimize open hole and amount of contaminated soil left exposed. Soil excavation plan to be developed during remedial design will describe how excavation will proceed. <u>Dewatering</u> • After sheet pile wall installation, dewater each cell prior to and during excavation and treat as described below. Dewatering of RTA estimated to require approximately 2 weeks (assume 200 gpm dewatering rate). • Estimated total water volume during construction 3,588,200 gallons.

Table 3-3
Detailed Components of Assembled Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

Alternative Number	Description/Components
	– Estimated water volume from dewatering RTA 2,972,900 gallons. – Estimated water volume from leakage through sheet pile wall and native clay layer during construction of entire RTA estimated at 171,300 gallons and water volume from rainwater estimated at 444,000 gallons. • Estimated water volume accumulated in treatment cells during 5 years of biocell operation 10,422,600 gallons based on estimated leakage through sheet pile wall and native clay layer of approximately 4 gpm. <u>Treatment and Disposal of Water from Dewatering</u> • Treat water from dewatering of excavations during construction and water from dewatering biocells during operation, using modular treatment system consisting of: – Oil/water separator - sized for oil and grease removal at design flow rate of 200 gpm for water and 10 gpm for LNAPL. – Settlement tank(s) - sized for TSS settlement based on residence time in relation to maximum flow rate and typical PVSC TSS criteria (250 mg/L); two 5,000 gallons polypropylene tanks included. Size depends on particle size, presence of colloids, etc.; to be finalized during design. – Treatment system components (types and size) are based on discharge to POTW. There is no data on oil and grease in groundwater within the RTA. Groundwater quality in relation to discharge limits would need to be verified during design and system components adjusted. Discharge limits on which system described in this FFS is based, are listed in Section 2. • Discharge treated effluent to KMUA/PVSC via sewer connection. • Sample treated effluent to monitor compliance with PVSC requirements. <u>Construction of Bioremediation Cells</u> • Prepare excavated soil by homogenizing and mixing with bulking agent assumed to be wood chips. Total volume of soil requiring treatment for all six cells 42,400 CY. Volume estimated to increase to 70,800 CY as a result of adding bulking agent. Mixing to be accomplished in small batches within each cell. • *Install nonwoven geotextile on top of exposed clay (bottom layer of biocell). Estimated area 176,800 SF.* • Install air distribution piping: 2-inch-diameter perforated PVC piping to be installed in a 12-inch pea gravel distribution layer. Piping installed in a grid layout with 30-foot spacing between each pipe to achieve a width of influence of 15 feet on either side of distribution pipe. Nonperforated 2-inch-diameter PVC piping will be installed in a 3-foot-deep trench to connect perforated air distribution piping to air blower located within treatment building. Estimated length of PVC perforated piping 5,300 feet. Estimated length of PVC nonperforated piping 1,900 feet. • Install nonwoven geotextile on top of pea gravel. Estimated area 176,800 SF. • Place amended soil on top of geotextile, expected height 7 to 8 feet above ground surface. This elevation accounts for adding 2 feet for piping layers and addition of bulking material. • Install nonwoven geotextile on top of amended soil. Estimated area 176,800 SF. • Install air collection/nutrient delivery piping: 2–inch-diameter perforated PVC piping to be installed in a 12-inch sand distribution layer. Same arrangement and piping lengths as above. • Install nonwoven geotextile on top of sand. Estimated area 176,800 SF. • Install 60-mil HDPE flexible membrane liner (FML) on top of geotextile. Estimated area 176,800 SF. • Install sand drainage layer on top of FML (6 inches thick) and vegetative support layer (6 inches think) on top of sand. • Install monitoring wells in each cell of biocell (assume two per cell). • Seed and mulch to create vegetative cover. <u>Water Collection and Nutrient Delivery Systems Within Biocell</u> • Install collection system for water accumulated in biocell. System consists of a submersible pump placed in a sump located in southwestern corner of each cell, total of six pumps. Each sump to be connected via 2–inch-diameter HDPE pipe to onsite modular treatment system. Estimated pipe length 1,000 feet. Note that surface runoff over the area of the biocell will be over the uncontaminated soil cover. This flow may be either allowed to flow through sheet flow to the remainder of the site or be directed via a storm sewer to the drainage culvert. • Install insulated remediation building with water, sanitation, electrical service, lights, HVAC, etc. • Install air distribution blowers (two blowers, each with 400 scfm capacity at 10 psi, supply air flow at 400 scfm). Blowers can be used to inject air into air distribution system, extract from air collection system, or do both simultaneously. • Install nutrient delivery equipment including delivery pump (10 gpm at 50 psi) and mixing tank (500 gallons). <u>Soil Backfill and Compaction</u>

Table 3-3
Detailed Components of Assembled Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

<table>
<tr><th>Alternative Number</th><th>Description/Components</th></tr>
<tr><td></td><td>

Backfill and compact. Note that import of clean soil is not needed because reduction in volume as a result of offsite disposal of concrete debris and soil from two areas with LNAPL in monitoring wells will be offset by volume of augmentation material added to soil before it is placed back into biocell.
Replace berm that needed to be excavated to construct biocell with the same soil to pre-remedial dimensions (assumed that following supplemental pre-design investigation, the material is found to be of acceptable characteristics).

<u>Transportation and Offsite Disposal of Other Wastes</u>

Transport for offsite disposal/recycling concrete foundations and building debris. Estimated concrete volume 900 CY, assumed nonhazardous.
Transport for offsite disposal soil from two areas where measurable product thickness is observed in wells. Estimated soil volume 2,600 CY, assumed nonhazardous. Treat soil via stabilization if needed, prior to offsite transport for disposal.
Transport for offsite disposal/recycling LNAPL separated from water during dewatering. Estimated volume 59,500 gallons, assumed nonhazardous.
Dispose of/recycle above waste streams in RCRA Subtitle D facilities.

<u>Operations and Maintenance</u>

Operate air distribution system, manifolded to six cells for continuous simultaneous aeration or with automatic switching so only one cell is operated at a time for a brief period (4 to 6 hours).
Install a programmable logic controller and telemetry system to enable automated operation and monitoring (parameters and alarms) of air distribution system.
Intermittently deliver nutrients – four doses assumed per year. During nutrient delivery, air distribution would be shut down. Nutrients delivered are based on the following by volume: 0.015 percent nitrogen, 0.001 percent phosphorous, and 0.005 percent potassium.
Inspect and maintain surface cover weekly, cut vegetation weekly during summer.
Monitor system performance and operation

Collect samples from vapor effluent for field screening (monthly) and for laboratory analysis (annual).
Collect required effluent samples from modular treatment system (quarterly).
Submit quarterly monitoring reports to PVSC.

<u>Verification Sampling and 5-year Reviews</u>

Monitor vapor from dry monitoring wells and once VOCs concentrations are low, conduct respiration testing (annually at a minimum). Once respiration test results indicate low biological activity, collect subsurface soil samples using direct-push technology through liner, and analyze for select parameters to be identified during design. Assume 3 events.
Once vapor and soil samples suggest PRGs may have been achieved, discontinue operation of aeration and water collection systems and flood cells with clean water (may require several weeks).
Sample soil and groundwater from monitoring wells, monitor for presence of LNAPL, and analyze samples for select parameters to be identified during design. Assume three events to confirm.
Perform one 5-year review.

<u>Closure</u>

Pull sheet pile wall and remove from site at end of operation period.
This alternative assumes that biocell components will be left in place for potential future use as part of overall site remedy.

Construction of this alternative is estimated to require less than 1 year. This alternative is anticipated to achieve established PRGs within 3 to 8 years of startup although it is possible that this duration extends beyond this estimated duration. Duration is assumed to be 5 years for the purpose of estimating the costs in this FFS.
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<tr><td>3</td><td>
<u>Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soil</u>
This alternative includes the following components:
<u>Pre-Design Investigation</u>

Same to Alternative 2.

<u>Remedial Design</u>
</td></tr>
</table>

Table 3-3
Detailed Components of Assembled Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

Alternative Number	Description/Components
	• Similar to Alternative 2; focuses on parameters applicable to soil washing (for example, chemical dosage, water usage, treatment efficiency, etc.). <u>Pre-Remediation Site Work</u> • Similar to Alternative 2 except sheet pile wall to be installed one cell at a time and reused. Length of sheet pile wall covers perimeter of largest cell (estimated 1,000 feet) and perimeter of two areas where LNAPL is found in monitoring wells (estimated 600 feet). Estimated total length 1,600 feet. <u>Soil Excavation</u> • Assumed to proceed in the same manner as Alternative 2. <u>Dewatering</u> • Assumed that dewatering during excavation would be same as under Alternative 2. During soil washing, rinsate water will be generated. Estimated water volume 120,000 gallons based on 15,000 gallons per month for 8 months of operation. Estimated total water volume 3,708,157 gallons. <u>Treatment and Disposal of Water from Dewatering</u> • Water from dewatering to be treated same as under Alternative 2. Rinsate from soil washing to be treated by soil washing vendor for specific residuals expected as a result of soil washing process. Rinsate can then be discharged through treatment system used for water from dewatering. <u>Soil Washing</u> • Mobilize soil washing treatment units assumed in the FFS to have maximum capacity of 45 tons per hour (average operating capacity of 20 tons per hour). • Soil washing process (units and products used) to be designed by vendor to correspond to site characteristics and may include multiple processes, including debris screening, rotary trammel screening, soil washing scrubbing unit, filter press dewatering, vibratory screen dewatering, and wastewater treatment plant. • Stage soil in batches following soil washing and sample to confirm PRGs were met. Batch size may vary depending on size of treatment plant and other considerations; example batch size could be the volume treated in a day. – Return soil that do not meet PRGs for additional soil washing. – Backfill and compact soil that meet PRGs. • Treat rinsate from soil washing using treatment system provided by vendor (note that this is a separate system from system used to treat water from dewatering). • Characterize filter cake. Volume estimated to be 15 percent of processed soil, or 6,400 CY; assumed hazardous. • Following backfilling, install monitoring wells in each cell of RTA (assumed two per cell). <u>Soil Backfill and Compaction</u> • Import clean soil to offset waste streams that reduce volume of soil available for backfilling following soil washing. Estimated 9,900 CY will be needed to offset volumes of concrete debris, soil from two areas where LNAPL was found in wells, and filter cake. • Backfill and compact. • Following backfilling, install 2 groundwater monitoring wells in each cell. • Replace berm that needed to be excavated with the same soil to pre-remedial dimensions (assumed that following supplemental pre-design investigation, the material is found to be of acceptable characteristics). <u>Transportation and Offsite Disposal of Other Wastes</u> • Similar to Alternative 2 but also includes disposal of wastes from soil washing: – Transport for offsite disposal filter cake. Estimated volume 6,400 CY, assumed hazardous. Treat filter cake with stabilization, if needed, prior to offsite transport for disposal. Disposal at RCRA Subtitle C facility. – Discharge to PVSC treated rinsate from soil washing. Estimated 120,000 gallons. – Assumed no LNAPL separated from rinsate, LNAPL assumed to be bound to filter cake. <u>Verification Sampling</u> • After backfill and compaction, discontinue dewatering sump operation and allow cells to flood via surface water infiltration (may take several weeks). • Sample soil and groundwater from monitoring wells, monitor for presence of LNAPL, and analyze samples for

Table 3-3
Detailed Components of Assembled Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

Alternative Number	Description/Components
	select parameters to be identified during design. Assume three events to confirm. Closure • Pull sheet pile wall and remove from site. Operations and Maintenance • None; no 5-year reviews because of short remedy duration. After implementation, which is estimated to require slightly over 1 year, this alternative is expected to achieve the established PRGs.
4	**Excavation and Offsite Disposal at TSDF** This alternative includes the following components: Pre-Design Investigation • Same as Alternative 2. Remedial Design • Similar to Alternative 2 but without treatability testing. Pre-Remediation Site Work • Similar to Alternative 2, except install isolation sheet pile wall around entire RTA and between cells. Estimated length 3,700 feet to depth of 35 feet bgs. Soil Excavation • Excavate and stockpile 24,000 SF of the approximately 10-foot-high soil berm over area of RTA, and stage onsite in stockpiles. Estimated volume 8,900 CY. • Excavate concrete foundations within RTA. Concrete foundations assumed to cover approximately 100 feet by 50 feet with an assumed thickness of 24 inches. Also assumed 500 CY of miscellaneous concrete debris in northern triangular RTA. Estimated volume 900 CY. • Excavate soil within RTA. Estimated 176,800 SF to average depth of 7 feet bgs. Estimated volume 45,000 CY. • Excavation to proceed sequentially in six cells, approximately 30,000 SF each, covering entire RTA. Within each cell, work to proceed in small sections (excavate, stockpile, backfill) to minimize open hole and amount of contaminated soil left exposed. Soil excavation plan to be developed during remedial design will describe how excavation will proceed. • Following backfilling, install two groundwater monitoring wells in each cell. Dewatering • Same as Alternative 2 during construction. Treatment and Disposal of Water from Dewatering • Same as Alternative 2. Transportation and Offsite Disposal of Other Wastes • Transport for offsite disposal/recycling concrete foundations and building debris. Estimated concrete volume 900 CY, assumed nonhazardous. • Transport for offsite disposal soil within RTA. Estimated soil volume 45,000 CY, assumed nonhazardous. Treat soil via stabilization if needed, prior to offsite transport for disposal. • Transport for offsite disposal/recycling LNAPL separated from water during dewatering. Estimated volume 59,500 gallons, assumed nonhazardous. • Dispose of/recycle above waste streams in RCRA Subtitle D facilities. Soil Backfill and Compaction • Import clean soil to replace excavated soil and concrete. Estimated 45,900 CY. • Backfill and compact. • Replace berm that needed to be excavated with the same soil to pre-remedial dimensions (assumed that following supplemental pre-design investigation, the material is found to be of acceptable characteristics). Verification Sampling • Discontinue dewatering sump operation and allow cells to flood via surface water infiltration (may take several

Table 3-3
Detailed Components of Assembled Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

Alternative Number	Description/Components
	months). • Sample soil and groundwater from monitoring wells, monitor for presence of LNAPL, and analyze samples for select parameters to be established during design. Assume one event to confirm. <u>Closure</u> • Maintain sheet pile wall around RTA but pull up from a depth of approximately 35 feet bgs to approximately 6 feet bgs, and cut off excess just below grade. Finish grade such that a greater portion of surface water infiltration per square foot occurs within RTA versus surrounding areas to maintain slight positive hydraulic gradient from within RTA to surrounding areas. <u>Operations and Maintenance</u> • None; no 5-year reviews because of short remedy duration. After implementation, which is estimated to require approximately 8 months, this alternative would achieve the established PRGs.

Notes:
All quantities are rounded to the nearest 100.
Refer to Appendix A for estimated quantities.

Table 4-1
Detailed Analysis of Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny, New Jersey

	Evaluation Criteria	Alternative 1 No Action	Alternative 2 Construction and Operation of Onsite Biocell	Alternative 3 Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soils	Alternative 4 Excavation and Offsite Disposal at TSDF
1	**Overall Protection of Human Health and the Environment**	**Poor - This alternative would not provide protection of human health and the environment. The principal threat LNAPL would continue to pose a risk as a result of leaching contaminants to groundwater. Potential for exposure to groundwater is low, however, since it is not used for potable supply.**	**Good - This alternative would provide overall protection of public health and the environment through the destruction rather than the transfer to another media of the principal threat LNAPL.**	**Good - This alternative would provide protection of public health and the environment at the site through the treatment of the media and the removal / transfer of the principal threat LNAPL for offsite disposal at an approved facility.**	**Good - This alternative would provide protection of public health and the environment at the site through the removal of the principal threat LNAPL for offsite disposal at an approved protective facility.**
a	Are the long term risks eliminated, reduced, or controlled?	This alternative would not reduce or eliminate the long term risks associated with the principal threat LNAPL.	The long term risks associated with the principal threat LNAPL are expected to be reduced to the PRGs. The reduction would be achieved through treatment (the biodegradation of the principal threat LNAPL). The toxicity, mobility, and volume of the principal threat LNAPL would be reduced rather than transferred to another media or offsite. The treatment is considered irreversible although pockets of untreated media may be left within the biocell.	The long term risks associated with the principal threat LNAPL at the site are expected to be reduced to the PRGs. The reduction would be achieved through treatment, however, the toxicity, mobility, and volume of the principal threat LNAPL would be transferred offsite to a disposal facility. This alternative transfers more volume offsite that has a higher toxicity than Alternative 2 (filter cake and residuals from the treatment of the blowdown water from the soil washing process). The treatment of the onsite soil is considered irreversible and since the treatment is ex situ, it is likely that it is more uniform over the volume of media that is treated.	The long term risks associated with the principal threat LNAPL at the site are expected to be reduced to the PRGs. The reduction would be achieved through the transfer of the entire volume of soil containing the principal threat LNAPL for offsite disposal.
b	Does alternative pose any unacceptable short term risks?	This alternative would not result in additional short term risks as there would be no changes associated with implementation.	Some short term risks are expected during construction but can be managed through engineering controls. No unacceptable short term risks are expected.	More short term risks are expected during construction than Alternative 2 due to the need for more trucking for offsite disposal as well as the import of clean fill. Risks during implementation can be managed through engineering controls. No unacceptable short term risks are expected although more safety controls would be required than under Alternative 2.	More short term risks are expected during construction than both Alternatives 2 and 3 due to the need for significantly more trucking for offsite disposal and import of clean fill. Risks during implementation can be managed through engineering controls. No unacceptable short term risks are expected although more safety controls would be required than for the other alternatives.
c	Does it affect other media in a +ve or -ve way?	This alternative would not affect other media in a positive way.	A reduction in the principal threat LNAPL (toxicity, mobility, and volume) would positively affect groundwater and surface water by reducing the potential for releasing contaminants to these media.	A reduction in the principal threat LNAPL (toxicity, mobility, and volume) would positively affect groundwater and surface water same as under Alternative 2.	A reduction in the principal threat LNAPL (toxicity, mobility, and volume) would positively affect groundwater and surface water same as under Alternative 2.
d	Does it achieve the PRGs?	This alternative would not achieve the PRGs.	The PRGs for the principal threat LNAPL are expected to be achieved. This alternative is expected to have limited effect on other COPCs. However, its design is versatile and offers the possibility to cycle operation between aerobic and anaerobic conditions as well as deliver reductive chemicals to achieve reductions in VOCs.	The PRGs for the principal threat LNAPL are expected to be achieved. This alternative as presented in this FFS is not designed to address other COPCs found in onsite soil. However, process can be designed to address other COPC and reduce their concentration to below the NJ soil cleanup standards for industrial use. It is reasonable to assume that the duration of implementation as well as the costs to include other COPCs in the soil washing process would be higher than presented in this FFS.	The PRGs for the principal threat LNAPL are expected to be achieved. This alternative would also achieve the NJ soil cleanup standards for residential use as clean fill would be imported.
e	What is the time required to achieve the PRGs?	Greater than 30 years.	PRGs are estimated to be achieved within 3-8 years of start of operation. Duration may increase but assumed to be 5 years for the purpose of estimating the costs in this FFS.	PRGs are expected to be achieved within a little over a year from start of implementation.	PRGs are expected to be achieved in approximately 8 months from start of implementation.
2	**Compliance with ARARs**	**Poor - This alternative will not address ARARs applicable to the presence of principal threat LNAPL.**	**Good - This alternative can be designed to comply with ARARs.**	**Good - This alternative can be designed to comply with ARARs.**	**Good - This alternative can be designed to comply with ARARs.**
a	Does the alternative meet chemical-specific ARARs?	Not applicable	This alternative can be designed to comply with chemical-specific ARARs.	Same as Alternative 2	Same as Alternative 2
b	Does the alternative meet action-specific ARARs?	Not applicable	This alternative can be designed to comply with action-specific ARARs.	Same as Alternative 2	Same as Alternative 2
c	Does the alternative meet location-specific ARARs?	Not applicable	This alternative can be designed to comply with location-specific ARARs. Note that onsite wetlands would need to be disturbed to implement the remedial action. Restoration of the wetlands is not included as part of any of the alternatives as the wetlands may be restored at a different location.	Same as Alternative 2	Same as Alternative 2

400141

Table 4-1
Detailed Analysis of Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny, New Jersey

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Construction and Operation of Onsite Biocell	Alternative 3 Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soils	Alternative 4 Excavation and Offsite Disposal at TSDF
3 Long term effectiveness	**Poor - This alternative would not result in any significant change of the risk that the principal threat LNAPL poses.**	**Moderate/Good - This alternative is expected to reduce the risk for the site following implementation and achieve the PRGs and RAOs within the RTA. Monitoring and various controls would be used during the implementation period to monitor progress. At the end of the implementation period, there will not be a need for long term controls as the soil within the RTA would be of similar characteristics to the surrounding soil (sheet pile wall would be removed). Some residual LNAPL as well as "dead" zones may remain due to limitations of aeration and slow biodegradation rates of large carbon-content petroleum compounds.**	**Good - This alternative is expected to reduce the risk for the site following implementation and achieve the PRGs and RAOs within the RTA. Monitoring and various controls would be used during the implementation period to monitor progress. At the end of the implementation period, there will not be a need for long term controls as the soil within the RTA would be of similar characteristics to the surrounding soil (sheet pile wall would be removed). Treatment is ex situ and is therefore expected to be more uniform.**	**Good - This alternative is expected to reduce the risk for the site following implementation and achieve the PRGs and RAOs within the RTA. At the end of the implementation period, the soil within the RTA would be cleaner than the surrounding soil and the sheet pile wall would need to be left in place to prevent recontamination. The sheet pile wall would need to be pulled slightly up and cut below the grade level. The surface would need to be graded to facilitate drainage towards the RTA such that a slightly positive hydraulic gradient is maintained from within the RTA to the outside.**
Magnitude of residual risk following remedy				
a Magnitude of risk following remedy implementation?	There will be no change in the residual risk following implementation of this alternative.	Potential risks associated with the presence of principal threat LNAPL would be reduced over the implementation period, however, some residual LNAPL may remain within the RTA after the PRGs have been achieved (for example, "dead" zones may occur within the RTA where biological activity does not progress. LNAPL would remain outside of the RTA. The reduction in risk would occur at a slower rate than under Alternatives 3 and 4. However, the reduction in risk would be the result of biodegradation of LNAPL and not as a result of transferring the contaminants to another media or sending them for offsite disposal. The sheet pile wall is assumed to be removed at the end of this alternative as the soil is expected to be treated to similar characteristics as the surrounding soil.	Potential risks associated with the presence of principal threat LNAPL would be reduced over the implementation period. While some residual LNAPL may remain, it may be less than under Alternative 2 as the soil is treated ex situ and treatment is expected to be more uniform. As with Alternative 2, LNAPL would remain outside of the RTA. The reduction in risk would occur at a rate that is faster than that of Alternatives 2 but slower than that of Alternative 4. However, the reduction in risk would be the result of transferring of the principal threat LNAPL from the soil to other media for offsite disposal (e.g., filter cake, blowdown water) and not from the biodegradation of the principal threat as under Alternative 2. The sheet pile wall is assumed to be removed at the end of the implementation period as the soil is expected to be treated to similar characteristics as the surrounding soil.	Potential risks associated with the presence of principal threat LNAPL would be eliminated over the implementation period - no residual LNAPL would remain and the NJ soil cleanup standards for residential use would be achieved. The reduction in risk for the site would occur faster than under Alternatives 2 and 3. However, the reduction would be the result of transferring of the principal threat LNAPL from the site for offsite disposal. At the end of the implementation period, the soil within the RTA would be cleaner than the surrounding soil and the sheet pile wall would need to be left in place to prevent recontamination. The sheet pile wall would need to be pulled slightly up and the surface graded to facilitate drainage towards the RTA such that there is a slightly positive hydraulic gradient from within the RTA to the outside.
b Magnitude of risk associated with generated treatment residuals and can it be managed?	Not applicable.	Low risk is associated with treatment residuals since LNAPL would undergo in-situ biological degradation and destruction. The treatment residuals expected to be produced are listed in Table 3-3 and Appendix B. Smaller soil volumes for offsite disposal would be produced under this alternative than under Alternatives 3 and 4. The quantity of water for disposal, however would be higher as water that accumulates in the biocell during the implementation period would need to be removed. The water would be treated and discharge is planned to a POTW. Where possible, residuals (concrete, LNAPL) would be recycled through permitted facilities. Disposal of soil residuals will be at permitted facilities.	Risk associated with treatment residuals is higher as more residuals requiring management are expected to be generated. The treatment residuals expected to be produced are listed in Table 3-3 and Appendix C. Due to the need for disposal of filter cake, the volumes of residuals for offsite disposal would be higher than under Alternative 2 . The quantity of water for disposal, however would be lower as there will be no biocell water requiring disposal. As with Alternative 2, the water would be treated and discharge is planned to a POTW. Where possible, residuals (concrete, LNAPL) would be recycled through permitted facilities. Disposal of soil residuals will be at permitted facilities.	Risk associated with residuals is the highest because soil containing principal threat LNAPL would be transferred for offsite disposal. The residuals expected to be produced are listed in Table 3-3 and Appendix D. The quantity of water for disposal would be lower for this alternative as there will be no biocell water and no soil washing blowdown requiring disposal. As with the other alternatives, the water would be treated and discharge is planned to a POTW. Where possible, residuals (concrete, LNAPL) would be recycled through permitted facilities. Disposal of soil residuals will be at permitted facilities.
Adequacy and reliability of controls				
c What is the likelihood that the technologies will meet required process efficiencies or performance specifications?	Not applicable.	In-situ biological degradation is expected to meet required performance specifications following treatability testing to support design.	The soil washing process is expected to meet required performance specifications following treatability testing to support design.	Excavation, transport and disposal are well established; rates used to estimate the costs and duration of this alternative in this FFS are expected to be met.
d What type and degree of long-term management is required?	Not applicable.	Long term management would be required throughout the implementation period (estimated to be 5 years) to operate the biocell and monitor its progress towards achieving the PRGs.	There will be no need for long term management as the PRGs are expected to be achieved at the end of the implementation period.	There will be no need for long term management as the PRGs are expected to be achieved at the end of the implementation period.
e What are the requirements for long - term monitoring and how significant are they?	Not applicable.	Long term monitoring to assess progress towards achieving the PRGs would include regular off-gas monitoring, soil gas sampling, and soil sampling. The discharge of the water accumulated in the biocell would also need to be monitored to document compliance with PVSC requirements. The process equipment will need to be monitored and maintained for proper performance over the period of implementation. Confirmation sampling will be needed at the end of implementation to document that the alternative has achieved the PRGs.	Progress towards achieving the PRGs would be monitored during the implementation of the soil washing process by sampling the washed soil before making the determination to backfill. There will be no need for long term monitoring following completion of the remedial action. Confirmation sampling will be needed at the end of implementation to document that the alternative has achieved the PRGs.	There will be no need for long term monitoring as the PRGs are expected to be achieved at the end of the implementation period. The clean borrow would need to be sampled before being imported to the site to demonstrate that it meets the PRGs.

400142

	Evaluation Criteria	Alternative 1 No Action	Alternative 2 Construction and Operation of Onsite Biocell	Alternative 3 Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soils	Alternative 4 Excavation and Offsite Disposal at TSDF
f	What O&M functions must be performed and how intensive are they?	Not applicable.	Implementation would require weekly site visits by a technician throughout the operating period for process monitoring and equipment maintenance purposes.	Once implementation is complete, the soil washing equipment would be removed from the site and there will be no need for O&M.	There will be no need for O&M functions as the PRGs are expected to be achieved at the end of the implementation period.
g	What difficulties and uncertainties may be associated with long-term O&M?	Not applicable.	Assessing progress towards achieving the PRGs would require interpretation of vapor and respiration test results to determine when soil samples should be collected. The soil data would be used to assess the progress towards achieving the PRGs and when treatment can be discontinued.	There will be no need for long term O&M.	Same as 3
h	What is the potential need for replacement of technical components?	Not applicable.	Remedial equipment will need to be replaced periodically throughout the 5 year treatment period. The equipment would be readily available and easy to maintain and replace.	There is no need for long term O&M and therefore, there would be no concerns that technical components would need replacement following implementation.	Same as 3
i	What would be the magnitude of threats or risks should technical components need replacement?	Not applicable.	Component failures are not expected to have a negative effect on the environment or community as they would not result in the release of contaminants / LNAPL beyond current presence. Biological activity is expected to continue although depending on how long the failure continues and whether there is a lack of supplied air, the bacterial population may transform from aerobic to anaerobic. Weekly visits and remote monitoring will be used to monitor that the equipment is operational.	There is no need for long term O&M and therefore, there would be no concerns associated with replacement of technical components.	Same as 3
j	What is the degree of confidence that controls can adequately handle potential problems?	Not applicable.	The site is currently inactive and fenced. Access to the site would continue to be controlled during the remedial action to prevent unauthorized visitors. Process controls and weekly site visits would be used to monitor performance.	Same as 2	Same as 2
k	What are the uncertainties associated with land disposal of residuals and untreated wastes?	Not applicable.	Some residual LNAPL may remain in the soil following implementation. Wastes that will be send for offsite disposal / recycling will be fully characterized. Based on characteristics, waste streams will be recycled where possible.	Some residual LNAPL may remain in the soils following implementation although may be less than under Alternative 2. Quantities of wastes that will be send for offsite disposal / recycling will be higher than under Alternative 2. As with Alternative 2, these wastes would be fully characterized prior to offsite disposal. Based on characteristics, waste streams will be recycled where possible.	Risk associated with residuals is the highest because soil containing principal threat LNAPL would be transferred for offsite disposal. As with the other alternatives, these wastes would be fully characterized prior to offsite disposal. Based on characteristics, waste streams will be recycled where possible.
4	**Reduction in toxicity, mobility, and volume**	**Poor - This alternative would not result in any significant changes in the TMV of the principal threat LNAPL.**	**Good - This alternative relies on irreversible biological mineralization treatment to reduce the TMV of the principal threat LNAPL, with limited quantities of treatment residuals produced.**	**Moderate - This alternative relies on irreversible treatment to reduce the TMV of the principal threat LNAPL in onsite soil. However, the LNAPL is transferred / concentrated to treatment residuals which require offsite disposal. This alternative transfers more volume offsite that has a higher toxicity than Alternative 2 (filter cake and residuals from the treatment of the blowdown water from the soil washing process).**	**Poor - This alternative relies on the transfer of the TMV of the principal threat LNAPL to offsite disposal facilities.**
a	Is treatment used to reduce TMV?	This alternative does not include any components that would affect the TMV of the principal threat.	Adding oxygen, promoting biological degradation, and physical treatment processes would reduce toxicity, mobility, and volume.	Physical and chemical processes would reduce the TMV in the treated soil but will transfer them to residuals that require offsite disposal.	Treatment is not used. TMV would be transferred to offsite disposal facilities.
b	Is treatment Irreversible?	Not applicable.	This alternative would address the principal threat identified at the site through the irreversible biological degradation of the organics. The soil following treatment is expected to have similar characteristics to the surrounding soil.	This alternative would address the principal threat identified at the site through irreversible treatment. The soil following treatment is expected to have similar to better characteristics than the surrounding soil.	Treatment is not used. TMV would be transferred to offsite disposal facilities.
c	Degree and quantity of TMV reduction:	Not applicable.	Treatability tests would be completed to optimize full scale biological activity and to determine the achievable reduction in LNAPL.	Treatability tests would be completed to optimize full scale design and to determine the achievable reduction in LNAPL.	No reduction in TMV. TMV would be transferred to offsite disposal facilities.

Table 4-1
Detailed Analysis of Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny, New Jersey

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Construction and Operation of Onsite Biocell	Alternative 3 Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soils	Alternative 4 Excavation and Offsite Disposal at TSDF
d Types and quantities of treatment residuals?	Not applicable.	The treatment residuals expected to be produced are listed in Table 3-3 and Appendix B. Smaller volumes for offsite disposal would be produced under this alternative than under Alternatives 3 and 4. The quantity of water for disposal, however would be higher as water that accumulates in the biocell during the implementation period would need to be removed. The water would be treated and discharge is planned to a POTW. Where possible, residuals (concrete, LNAPL) would be recycled through permitted facilities. Disposal of soil residuals will be at permitted facilities.	The treatment residuals expected to be produced are listed in Table 3-3 and Appendix C. Higher volumes of treatment residuals with concentrated toxics would be produced for offsite disposal under this alternative than under Alternative 2 (filter cake and blowdown water). The quantity of water for disposal, however would be lower than under Alternative 2 because there will be no water accumulation over a 5 year implementation period that would require disposal as with Alternative 2. As with Alternative 2, the water from dewatering during construction would be treated and discharge is planned to a POTW. Where possible, residuals (concrete, LNAPL) would be recycled through permitted facilities. Disposal of soil residuals will be at permitted facilities.	No treatment residuals; all soil containing principal threat LNAPL would be transferred for offsite disposal.
e Does alternative meet statutory preference for treatment as a principal element?	Not applicable.	This alternative meets the statutory preference for treatment - the treatment process would result in the destruction through biological degradation of principal threat LNAPL rather than its transfer to another medium.	This alternative meets the statutory preference for treatment of the principal threat although the treatment process would transfer / concentrate the contaminants into waste residuals that require offsite disposal.	This alternative does not meet the statutory preference for treatment of the principal threat.
5 Short term effectiveness	**Not applicable as there are no construction activities and therefore, no associated short term effectiveness issues.**	**Moderate - Some risks and environmental impacts associated with alternative; these can be controlled through engineering and process controls. Longer operating time would be needed until PRGs are achieved. This alternative also offers the highest potential for environmental sustainability improvement.**	**Moderate/Good - Risks and environmental impacts associated with this alternative are the same as with Alternative 2 but time until PRGs are achieved would be less. Short term risks can be controlled through engineering and process controls. This alternative also offers options for incorporating sustainability considerations, although significantly less that Alternative 2.**	**Poor/Moderate - This alternative has the shortest time to meet PRGs, but there are more short term risks associated with this alternative than with the other two alternatives due to the risks with the transport of large quantities of soil. These risks would be difficult to control and may outweigh the benefits of achieving the PRGs in less time. This alternative offers the least options for improving environmental sustainability.**
a Protection of community during remedial action:	Not applicable	There are no nearby residences that would be affected; any potential concerns would apply to commercial / industrial neighbors. Risks to the community associated with this alternative include vapors, dust, possible odor, and soil / sediment erosion. These would be the highest during construction and would be reduced during biocell operation. Emissions from the biocell during operation were estimated to be below regulatory levels. The risks would be mitigated through engineering controls such as soil erosion controls, dust suppressants, and controlling excavation rates to limit air emissions during excavation. Accidental spills during offsite transport of contaminated material can be minimized through the implementation of appropriate controls and spill response procedures.	Same as Alternative 2 except that the risks would be over a shorter duration as the implementation time for this alternative would be less than for Alternative 2.	In addition to the risks described under Alternative 2, this alternative presents significant risks to the community associated with the transport of large quantities of soil. The risks would be over a shorter duration as the implementation time for this alternative would be less than that of Alternatives 2 ad 3. Risks would be more difficult to control as they involve offsite transportation.
b Protection of workers during remedial action:	Not applicable	Potential risks to workers (physical and through exposure to chemical contaminants) during excavation, construction, and operation would be mitigated by adhering to health and safety plans and employing appropriate health and safety procedures and protective equipment.	Same as Alternative 2 except that the risks would be of shorter duration.	Same as Alternative 2 except that the risks would be of shorter duration.
c Environmental impacts during implementation:	Not applicable	This remedial action will need to disturb the onsite wetland area since the most significant principal threat LNAPL is found in this area. Other environmental impacts include air emissions (dust and vapors) and potential for contaminants migration via soil erosion (if not controlled). The impacts are expected to be controlled through the use of appropriate engineering and administrative control measures. Dust and erosion would be mitigated through engineering controls such as dust suppressants and limiting excavation rates to reduce vapor emissions.	Same as Alternative 2 except that the risks would be of shorter duration.	Same as Alternative 2 except that the risks would be of shorter duration.

Table 4-1
Detailed Analysis of Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny, New Jersey

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Construction and Operation of Onsite Biocell	Alternative 3 Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soils	Alternative 4 Excavation and Offsite Disposal at TSDF
		Disturbance of the wetland area is unavoidable as the most significant principal threat LNAPL is within this area. This alternative does not include restoration of the wetland area as this is assumed to either occur as part of the overall site remedy or as part of the redevelopment of the site.		
d Sustainability.	This alternative does not provide opportunities for sustainability considerations.	Table 4-2 presents a comparison of the sustainability potential offered by the alternatives. Alternative 2 is considered the most sustainable as it offers more opportunities to incorporate sustainability considerations into its implementation than the other alternatives. Alternative 2 generates limited waste, reduces the need for offsite disposal and the need to transport clean fill to the site from an off-site borrow source. There would be substantially less truck traffic and associated air emissions. Alternative 2 also reduces consumption of fresh water compared to Alternative 3. However, Alternative 2 requires a longer operating period than all other Alternatives (estimated 5-year operation) although principal threat LNAPL will be destroyed rather than transferred to another media / location. Alternative sources of energy could be used to support the operation of the biocell.	Table 4-2 presents a comparison of the sustainability potential offered by the alternatives. This alternative offers less opportunities to incorporate sustainability considerations into its implementation than Alternative 2. It would generate more wastes that would require offsite transport and disposal. There would be substantially more truck traffic and associated air emissions. Alternative 3 also uses more fresh water compared to Alternative 2 but would have a shorter implementation and therefore, lower energy needs.	This alternative offers the least options for incorporating sustainability considerations into the alternative design.
e Time until PRGs are achieved	Not applicable	Approximately 1 year of construction and estimated 3-8 years of operation, assumed to be 5 years for the purpose of estimating the costs in this FFS.	Estimated to be little over 1 year.	Estimated to be approximately 8 months.
6 Implementability	**Good - There are no actions to take.**	**Moderate/Good - The technology used for Alternative 2 is proven and components are commercially available. The design of the biocell provides high versatility and can be incorporated into a future remedial action for the overall site (e.g., used for air sparging or to deliver substrates for degradation of COPCs). Final deposition of above-grade portion biocell soil will need to be resolved during the full-scale remedy.**	**Moderate - The technology used for Alternative 3 is a specialty technology, which although commercially available has a limited number of vendors. The soil washing process can be designed to treat for other COPCs found in soil within the RTA.**	**Good - The technology used for Alternative 4 is proven and components are commercially available. However, disposal facility capacity will affect implementability and may result in delays.**
<u>Technical Feasibility</u> a Ability to construct and operate:	There are no technical impediments to implementing this alternative.	This alternative is considered very implementable from a constructability prospective. Possible challenges include sheet pile refusal, excavation dewatering and water treatment, biocell construction logistics, delays with material supplies, and phasing cell construction. Uncertainties in the depth and variability to the native clay layer may also present challenges during biocell construction.	This alternative is considered implementable from a constructability prospective. Because of the complexities of the equipment / process, the soil washing technology is expected to have a higher potential for delays associated with equipment problems. Other possible challenges are similar to Alternative 2 (sheet pile refusal, excavation dewatering and water treatment, phasing cell construction, and uncertainties in the depth and variability to the native clay layer).	Same as Alternative 2.
b Reliability of technologies and potential for schedule delays?	Not applicable	Low likelihood of schedule delays. Technology has been proven and materials, supplies, equipment are readily available.	Higher likelihood of schedule delays due to equipment problems that under Alternative 2.	Higher likelihood of schedule delays; approvals from disposal facilities will be required prior to beginning implementation in order to minimize schedule delays.
c *Ease of undertaking additional remedial actions:*	*Additional actions can be easily undertaken.*	*In place distribution piping could be utilized for future remedial actions such as air sparging and reductive dechlorination. Alternative may allow cost-saving benefits for potential future remedial actions to address remaining COPCs.*	*The soil washing process can be designed to treat for other COPCs found in soil within the RTA. According to commercial vendors of the technology, it would be possible to treat the soil to levels that would be below the NJ cleanup standards for nonresidential use. The cost and duration for this treatment are expected to be higher than presented for the alternative in the FFS.*	*There will be no need for additional remedial actions within the RTA as the soil would be replaced with clean fill.*

400145

Table 4-1
Detailed Analysis of Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny, New Jersey

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Construction and Operation of Onsite Biocell	Alternative 3 Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soils	Alternative 4 Excavation and Offsite Disposal at TSDF
		Construction of this alternative will result in raising the grade level within the RTA. If this alternative is not incorporated into a future overall site remedy (see below for versatility that this alternative offers for future treatment), the components of this alternative (e.g., near surface piping) will need to be removed. The material that is above grade can be spread and compacted to current grade level because following treatment, the material is expected to be of similar characteristics as the surrounding soil. Alternatively, the developer may decide to use the raised grade and import additional clean fill in support of redevelopment.	Following implementation, the RTA would be at grade.	Following implementation, the RTA would be at grade. However, surface grading would need to be maintained to facilitate surface drainage towards the RTA in order to maintain a slightly positive hydraulic gradient from within the RTA to the outside and thus prevent recontamination. This will need to be considered in future redevelopment plans for the site.
d Ability to monitor the effectiveness:	Monitoring techniques would be standard, readily available, and are expected to provide the needed information.	Regular vapor monitoring would provide indication on the progress of the biological degradation. Oxygen and nutrient delivery rates would be adjusted to maintain / optimize performance. Soil sampling can also be used to regularly confirm the progress. All monitoring techniques are standard, readily available, and are expected to provide the needed information to assess the progress of the technology.	Regular soil sampling would be used to confirm that the treated soil has met the PRGs. All monitoring techniques are standard, readily available, and are expected to provide the needed information to assess the effectiveness of the technology.	There will be no need to monitor effectiveness as the soil would be replaced with clean fill.
<u>Administrative Feasibility</u> e Ability to obtain approval from other agencies:	Not applicable.	This alternative will require coordination with the KMUA and PVSC with regard to sewer connections and discharge of treated water. Coordination with the NJDEP and other miscellaneous regulatory agencies would also be needed to coordinate compliance with substantive regulatory requirements (i.e. air emissions monitoring, wetlands, erosion controls).	Same as Alternative 2 although some additional coordination would be required for the disposal of the filter cake if characterization confirms that it is hazardous as assumed for this FFS.	Same as Alternative 2 although additional coordination would be required for the disposal of the large quantities of soil.
<u>Availability of Services and Materials</u> f Availability of offsite TSDF services and capacity?	Minimal capacity would be required to dispose of wastes generated from the monitoring activities.	Offsite facilities for the disposal of soil and LNAPL are expected to be readily available and able to handle the volumes generated from this alternative without delays as these volumes will be significantly lower than under Alternatives 3 and 4. Recycling of materials will be considered following characterization sampling.	Same as Alternative 2 although the volumes are expected to be higher.	Disposal facilities are expected to be available, however significant coordination would be required to secure space due to the large volume of soil requiring disposal.
g Availability of necessary equipment and specialists?	Services, equipment, and materials are available to perform required monitoring.	Equipment and specialists are commercially available and sufficiently proven. Competitive bidding would be possible for all system components. Treatability testing would be needed before design to develop design specification.	Limited number of commercial vendors of the technology although competitive bidding would still be possible . Treatability testing would be needed before design to develop design specification.	Equipment and specialists are commercially available and sufficiently proven. Competitive bidding would be possible for all system components.
7 Cost	Refer to Table 3-3.	Refer to Table 3-3.	Refer to Table 3-3.	Refer to Table 3-3.
8 Uncertainty	**Low - No potential for principal threat reduction without action.**	**Low/Moderate - The duration of the required aerobic bioremediation is uncertain until the rates of biodegradation are ascertained during bench-scale testing and initial biocell operation. While only limited biodegradation is expected to be needed to achieve the PRG for the principal threat LNAPL, the timeframe could extend upto 10 years if biodegradation of the large carbon petroleum compounds proves critical to achieving PRG.**	**Moderate - The level of design detail available from the vendors was more limited than the other alternatives, and therefore handled through increased contingency. Bench scale testing will be critical to define the required process for the Diamond Head site (for example, chemicals and soil washing methods) and strength and magnitude of residuals (such as filter cake) and associated pre-treatment and disposal methods.**	**Low - Excavation, hauling, and disposal facilities were consulted to develop this alternative; however, capacity may still be an issue. Uncertainty also exists with regard to the ability of maintain regrading of the site during redevelopment in order to direct surface runoff to the RTA as well as with regard to partial sheet piling to mitigate recontamination of clean fill. Some long-term pumping may be needed as a contingency to prevent surrounding contaminated groundwater from flowing into the RTA until the full-scale remedy is complete. There also will be considerations on how any isolation system left in place would be incorporated into future redevelopment plans for the site.**

400146

Table 4-2
Sustainability Analysis of Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny, New Jersey

Sustainability Core Elements of Green Remediation	Alternative 2	Alternative 3	Alternative 4
Energy Requirements of the Treatment System			
This alternative can use low-energy demand technologies.	✓		
This alternative can rely on on-site sources of energy generation (example, solar panels).	✓✓		
This alternative can use energy-efficient equipment.	✓	✓	✓
Air Emissions			
This alternative reduces air emissions resulting from transportation of soil (importing clean fill and disposal of soil).	✓	✓	
This alternative requires less vehicle traffic and minimizes truck idling.	✓	✓	
This alternative can be designed to reduce dust generation during implementation.	✓	✓	✓
Water Requirements and Impacts on Water Resources			
This alternative reduces consumption of fresh water.	✓		✓✓
This alternative can re-use treated water.	✓		
This alternative can use native vegetation.	✓	✓	✓
This alternative would prevent nutrient loading to nearby water bodies.	✓	✓	✓
Land and Ecosystem Impacts			
This alternative would rely on passive energy technologies such as bioremediation.	✓		
This alternative would minimize disturbance to local environmental resources / habitats.			
Material Consumption and Waste Generation			
This alternative reduces waste production.	✓✓		
This alternative allows for recycling / reclaiming of waste residuals, where possible (e.g., concrete, LNAPL).	✓	✓	✓
This alternative reduces need for removal of media for offsite disposal	✓✓	✓	
This alternative can use passive sampling to monitor the progress of remediation.			
Long Term Stewardship			
This alternative would result in less greenhouse gases contributing to climate change.	✓✓		
This alternative integrates an adaptive management approach.	✓	✓	✓
This alternative can use renewable energy to power long-term activities.	✓✓		
This alternative would solicit community involvement to increase public acceptance and awareness.	✓	✓	✓
This alternative minimizes active/long-term operations and maintenance.		✓	✓✓
Components of this alternative may be reused as part of the overall site remedy.	✓	✓	✓
This alternative allows for future redevelopment of the site.	✓	✓	✓

Note:

✓✓ (multiple checks) indicate a better alternative than others.

References:

USEPA, Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites, April 2008.

USEPA, Green Remediation: Best Management Practices for Excavation and Surface Restoration, December 2008.

Table 4-3
Summary of Costs for Remedial Action Alternatives
Diamond Head Oil Superfund Site, Kearny NJ

Cost Type	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Total Estimated Present Worth Costs				
Capital Cost	$0	$16,081,665	$18,557,073	$19,452,406
O&M Cost (1)	$0	$1,237,312	$0	$0
Periodic Cost	$0	$19,875	$0	$0
Total Estimated Costs	$0	$17,338,852	$18,557,073	$19,452,406
Cost Sensitivity Analysis				
Cost of Sheet Pile Wall				
LNAPL Sheet Pile Cost	$0	1,008,000	1,008,000	NA
Isolation Sheet Pile Cost (w/salvage)	$0	4,792,000	2,660,000	4,517,000
Subtotal Sheet Pile Cost	$0	5,800,000	3,668,000	4,517,000
Estimated Range of Costs	$0	From $11,538,852 To $17,338,852	From $14,889,073 To $18,557,073	From $14,935,406 To $19,452,406

(1) The annual O&M costs for Alternative 2 (not present worth) are estimated at $207,000.

Figures

Source: Hagstrom Union/Hudson/Essex County Atlas, 1990

Hudson County, Page 5, Grid C-7

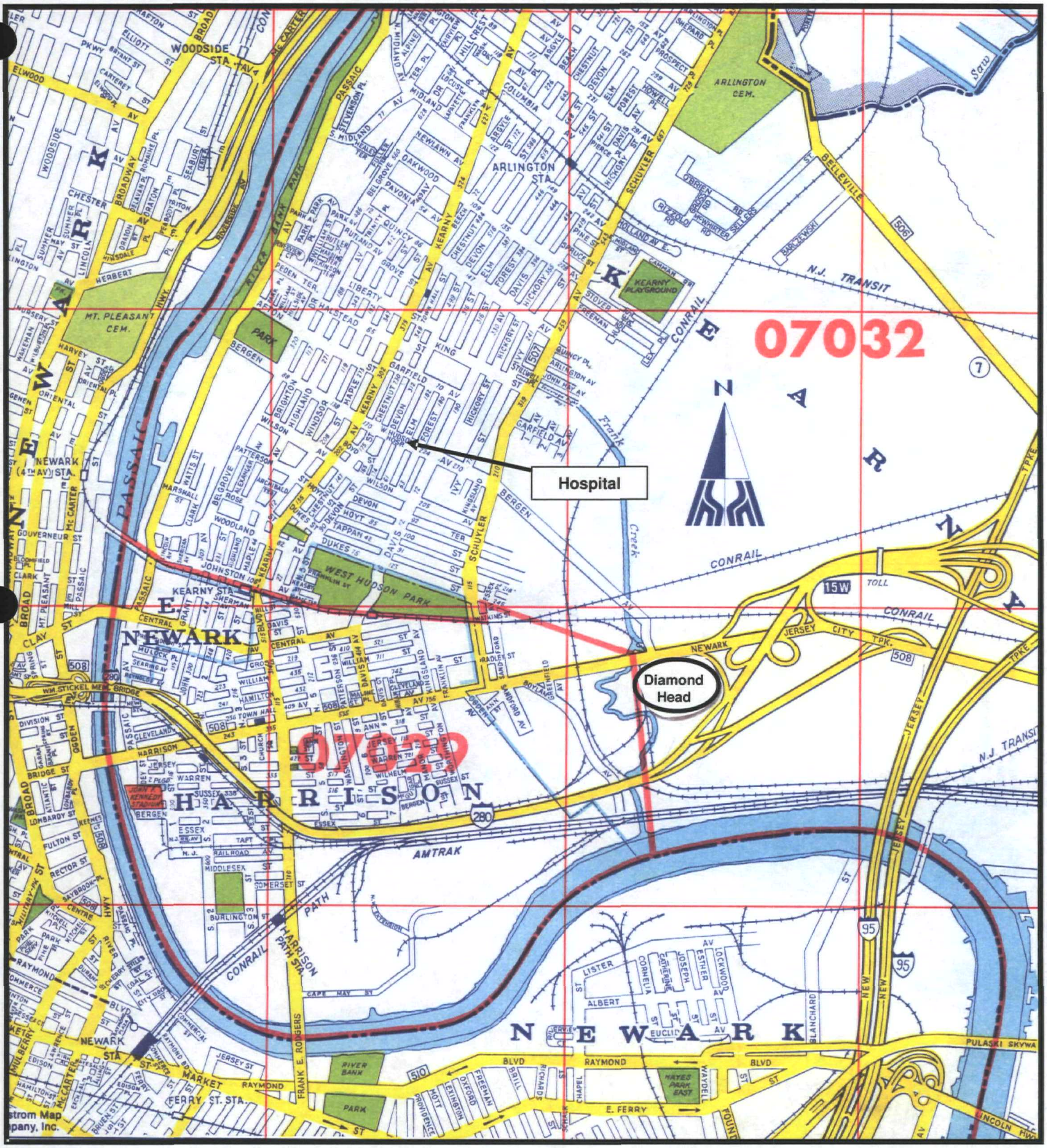


Figure 1-1

Diamond Head Oil - Site Location Map
Vacant Lot: *East of Campbell Foundry - 1235 Harrison Ave.*
Kearny, NJ 07032 (Hudson County)

See Also: USGS 7.5' Quadrangle: Elizabeth, NJ: Photorevised 1981
40º 44' 50" lat., 74º 07' 55.9" long. (NAD 83)

\\aphrodite\proj\USACE\359471DiamondHead\MapFiles\359471_OU2_RI-FS_Phase1\Figure 1-2 - Site Map.mxd

Legend

- Temporary Gravel Road
- Delineated Wetlands
- Extent of Historical Source Area (1976 Aerial Photo)

N

0 87.5 175 350 Feet

Figure 1-2
Site Map
Diamond Head RI/FS
Kearny, NJ

CH2MHILL

\\aphrodite\proj\USACE\359471DiamondHead\MapFiles\359471_OU2_RI-FS_Phase1\Figure 1-3 - Phase 1 RI Investigation Locations.mxd

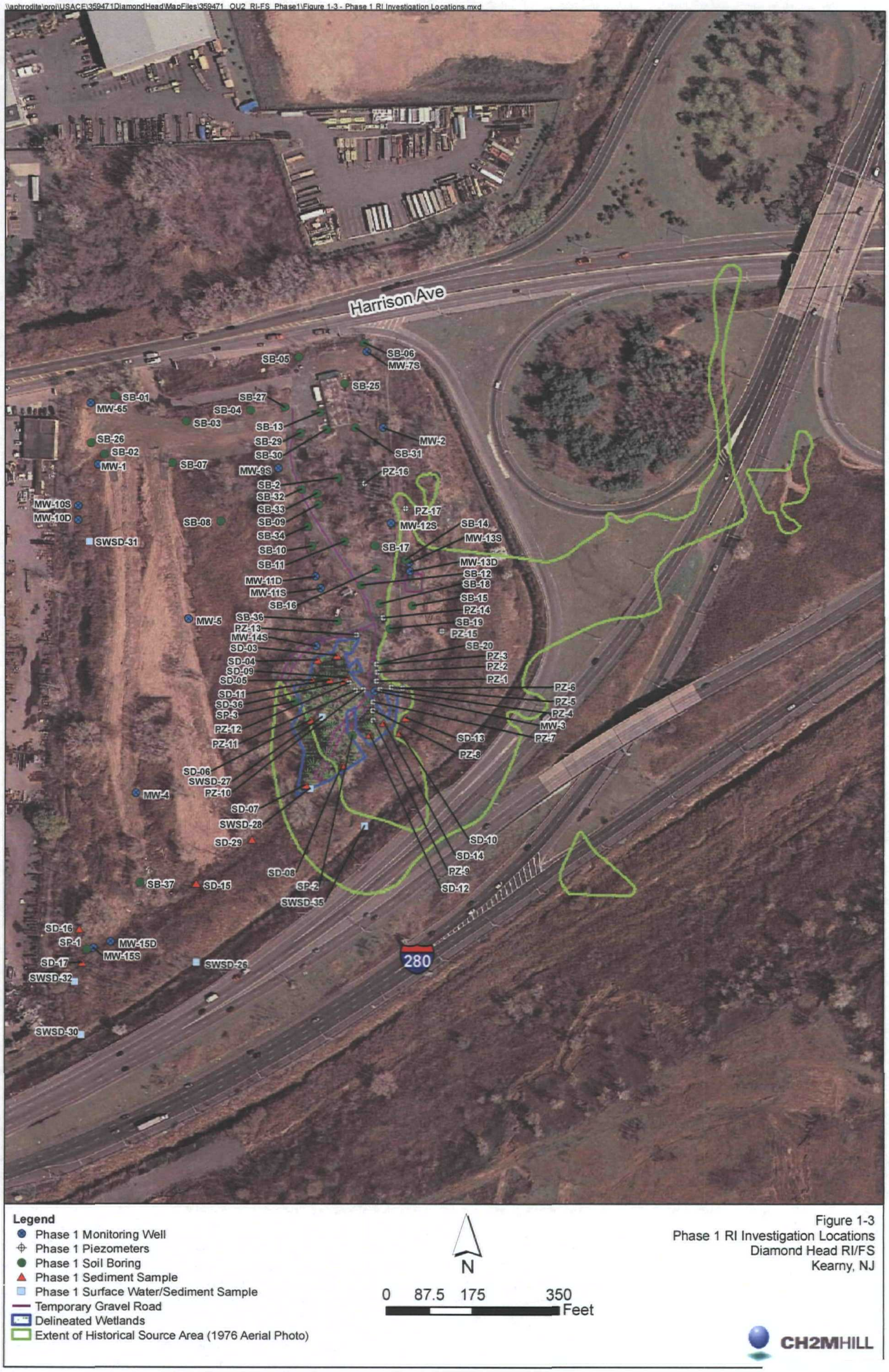
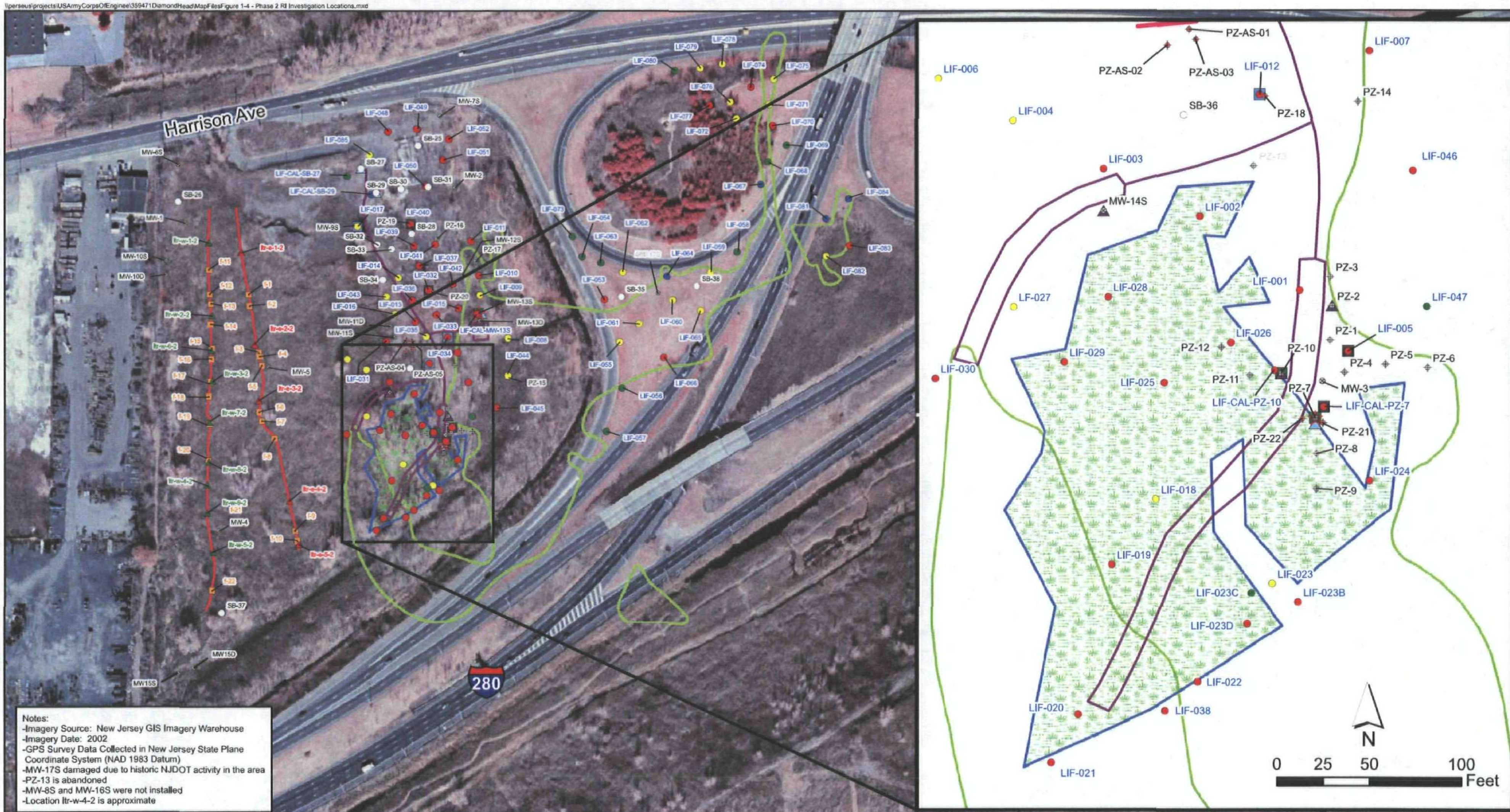


Figure 1-3
Phase 1 RI Investigation Locations
Diamond Head RI/FS
Kearny, NJ



Legend

- Phase 1 Monitoring Wells
- Phase 1 Piezometers
- Phase 2 RI Temporary Piezometers
- West Trench Samples
- East Trench Samples
- Trench Features
- RE Response < 10%
- RE Response 10-15%
- RE Response 15-40%
- RE Response > 40%
- Phase I Soil Boring
- LNAPL GW Pair Samples (PZ-7, MW-13S)
- SPLP Samples (MW-13D, MW-14S, PZ-2, PZ-10)
- LIF Baseline Logs (SB-27, SB-29, PZ-7, PZ-10, MW-13S)
- Intact Core Samples (LIF-040, LIF-32, LIF-CAL-PZ-7, LIF-005)
- LIF Soil Boring Logs (LIF-017, LIF-034, LIF-012)
- LNAPL Baseline LIF Correlation (PZ-7, PZ-10, MW-13S)
- Landfill Trench Centerline
- Air Sparge Trench
- Temporary Gravel Road
- Extent of Historical Source Area (1976 Aerial Photo)
- Delineated Wetlands
- Damaged / Abandoned Well

N

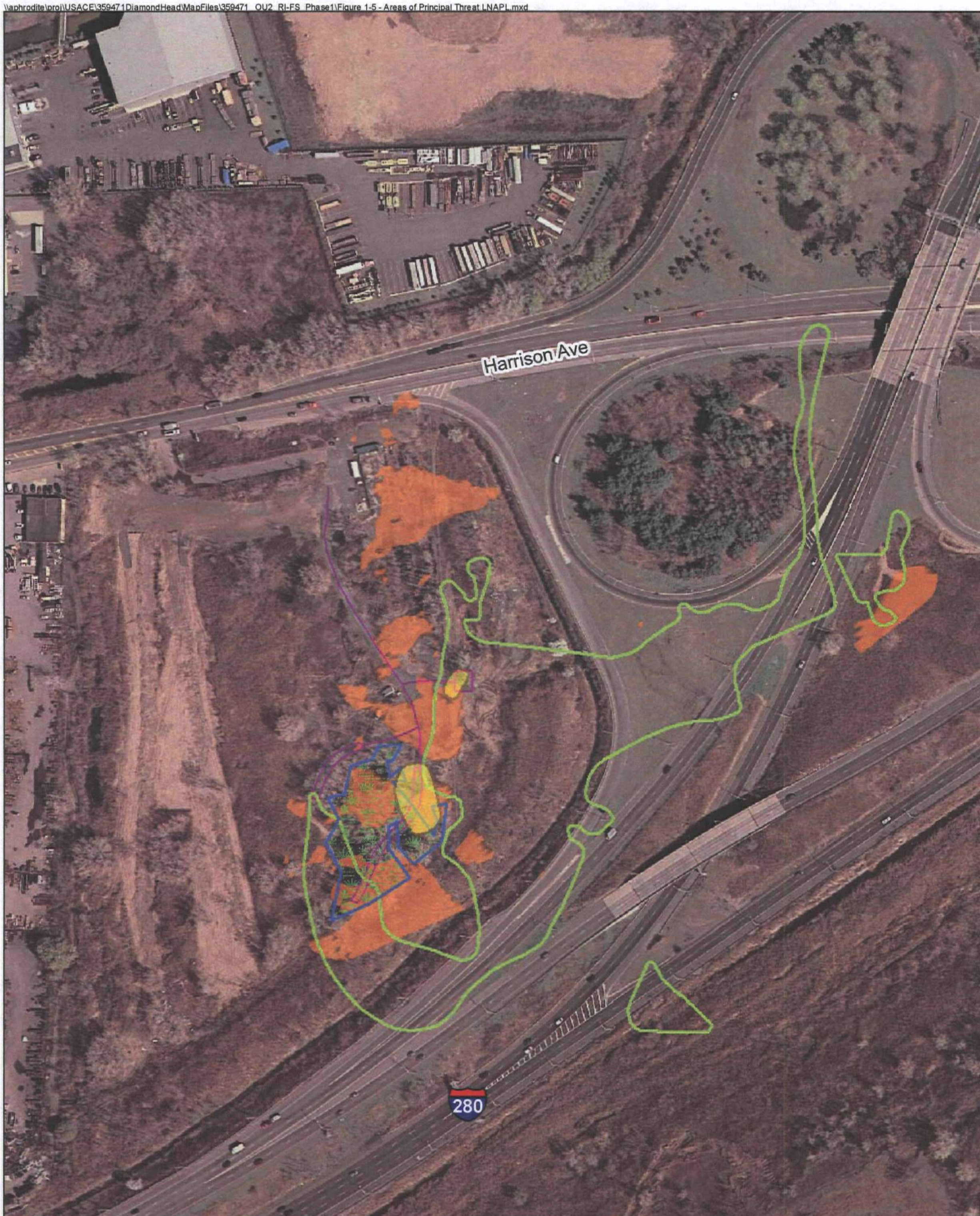
0 100 200 400 Feet

Figure 1-4
Phase 2 RI Investigation Locations
Diamond Head RI/FS
Kearny, NJ

CH2MHILL

400153

\\aphrodite\proj\USACE\359471DiamondHead\MapFiles\359471_OU2_RI-FS_Phase1\Figure 1-5 - Areas of Principal Threat LNAPL.mxd



Notes:
-Imagery Source: New Jersey GIS Imagery Warehouse
-Imagery Date: April 2008
-GPS Survey Data Collected in New Jersey State Plane Coordinate System (NAD 1983 Datum)
-PZ-13 is abandoned
-MW-8S and MW-16S were not installed
-Location ltr-w-4-2 is approximate
-One of the optional locations for wells MW-23 and MW-24 will be installed based on access agreements.

Legend
- Temporary Gravel Road
- Measureable LNAPL in Wells
- Delineated Wetlands
- Extent of Historical Source Area (1976 Aerial Photo)
- LNAPL Plume

N

0 87.5 175 350 Feet

Figure 1-5
Areas of Principal Threat LNAPL
Diamond Head RI/FS
Kearny, NJ

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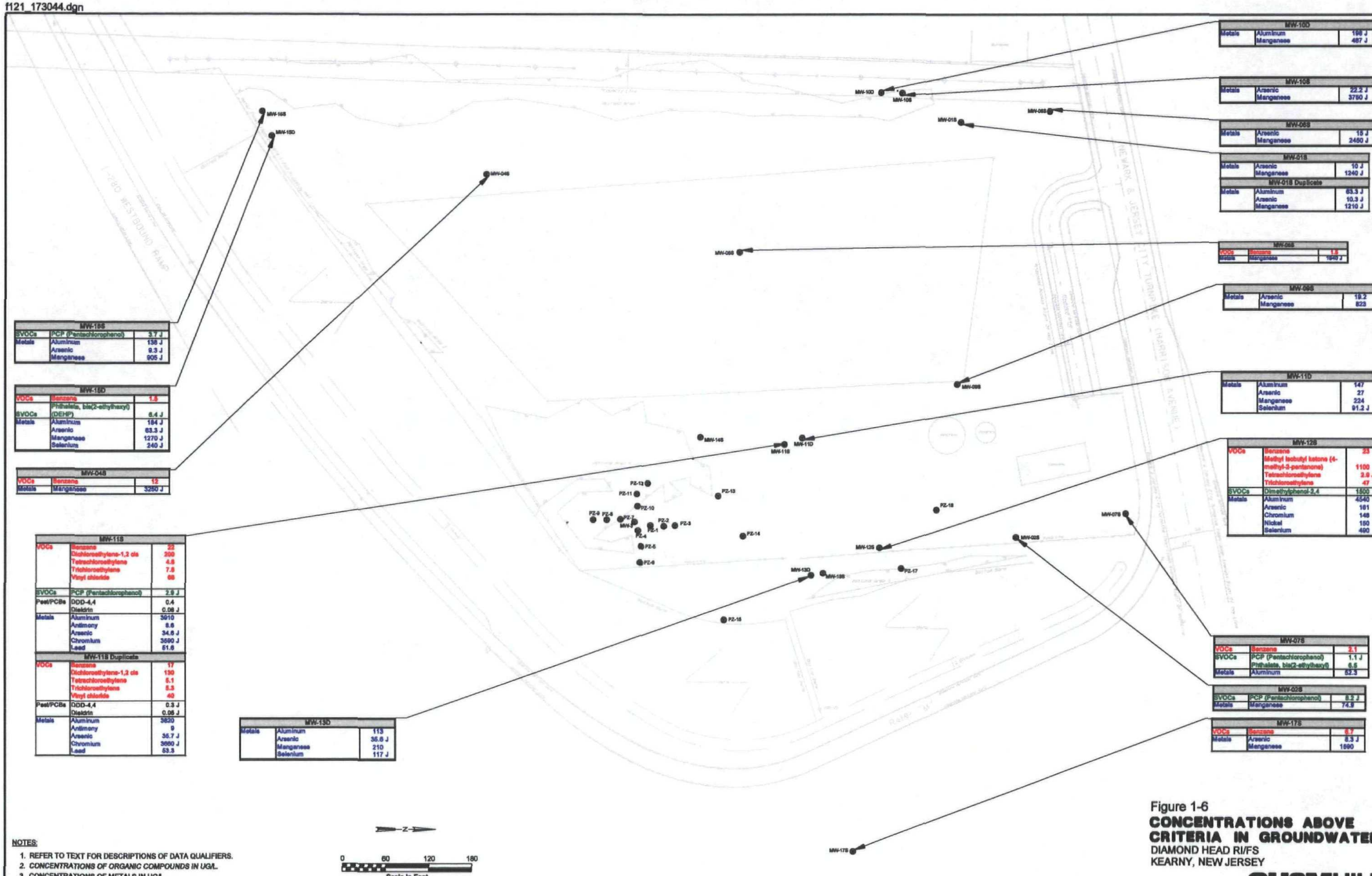

MW-10D		
Metals	Aluminum	198 J
	Manganese	487 J

MW-10S		
Metals	Arsenic	22.2 J
	Manganese	3750 J

MW-06S		
Metals	Arsenic	15 J
	Manganese	2450 J

MW-01S		
Metals	Arsenic	10 J
	Manganese	1240 J
MW-01S Duplicate		
Metals	Aluminum	63.3 J
	Arsenic	10.3 J
	Manganese	1210 J

MW-08S		
VOCs	Benzene	1.5
Metals	Manganese	1940 J

MW-09S		
Metals	Arsenic	19.2
	Manganese	823

MW-11D		
Metals	Aluminum	147
	Arsenic	27
	Manganese	224
	Selenium	91.2 J

MW-12S		
VOCs	Benzene	23
	Methyl isobutyl ketone (4-methyl-2-pentanone)	1100
	Tetrachloroethylene	2.9 J
	Trichloroethylene	47
SVOCs	Dimethylphenol-2,4	1500
Metals	Aluminum	4540
	Arsenic	161
	Chromium	148
	Nickel	150
	Selenium	490

MW-07S		
VOCs	Benzene	2.1
SVOCs	PCP (Pentachlorophenol)	1.1 J
	Phthalate, bis(2-ethylhexyl)	6.5
Metals	Aluminum	52.3

MW-02S		
SVOCs	PCP (Pentachlorophenol)	8.2 J
Metals	Manganese	74.9

MW-17S		
VOCs	Benzene	6.7
Metals	Arsenic	8.3 J
	Manganese	1690

MW-16S		
SVOCs	PCP (Pentachlorophenol)	3.7 J
Metals	Aluminum	138 J
	Arsenic	9.3 J
	Manganese	905 J

MW-15D		
VOCs	Benzene	1.5
SVOCs	Phthalate, bis(2-ethylhexyl) (DEHP)	6.4 J
Metals	Aluminum	184 J
	Arsenic	63.3 J
	Manganese	1270 J
	Selenium	240 J

MW-04S		
VOCs	Benzene	12
Metals	Manganese	3250 J

MW-11S		
VOCs	Benzene	22
	Dichloroethylene-1,2 cis	200
	Tetrachloroethylene	4.8
	Trichloroethylene	7.8
	Vinyl chloride	68
SVOCs	PCP (Pentachlorophenol)	2.9 J
Pest/PCBs	DDD-4,4	0.4
	Dieldrin	0.08 J
Metals	Aluminum	3910
	Antimony	8.6
	Arsenic	34.8 J
	Chromium	3590 J
	Lead	51.6
MW-11S Duplicate		
VOCs	Benzene	17
	Dichloroethylene-1,2 cis	130
	Tetrachloroethylene	5.1
	Trichloroethylene	5.3
	Vinyl chloride	40
Pest/PCBs	DDD-4,4	0.3 J
	Dieldrin	0.08 J
Metals	Aluminum	3820
	Antimony	9
	Arsenic	35.7 J
	Chromium	3650 J
	Lead	53.3

MW-13D		
Metals	Aluminum	113
	Arsenic	36.8 J
	Manganese	210
	Selenium	117 J

NOTES:

1. REFER TO TEXT FOR DESCRIPTIONS OF DATA QUALIFIERS.
2. CONCENTRATIONS OF ORGANIC COMPOUNDS IN UG/L.
3. CONCENTRATIONS OF METALS IN UG/L.

Figure 1-6
CONCENTRATIONS ABOVE CRITERIA IN GROUNDWATER
DIAMOND HEAD RI/FS
KEARNY, NEW JERSEY

CH2MHILL

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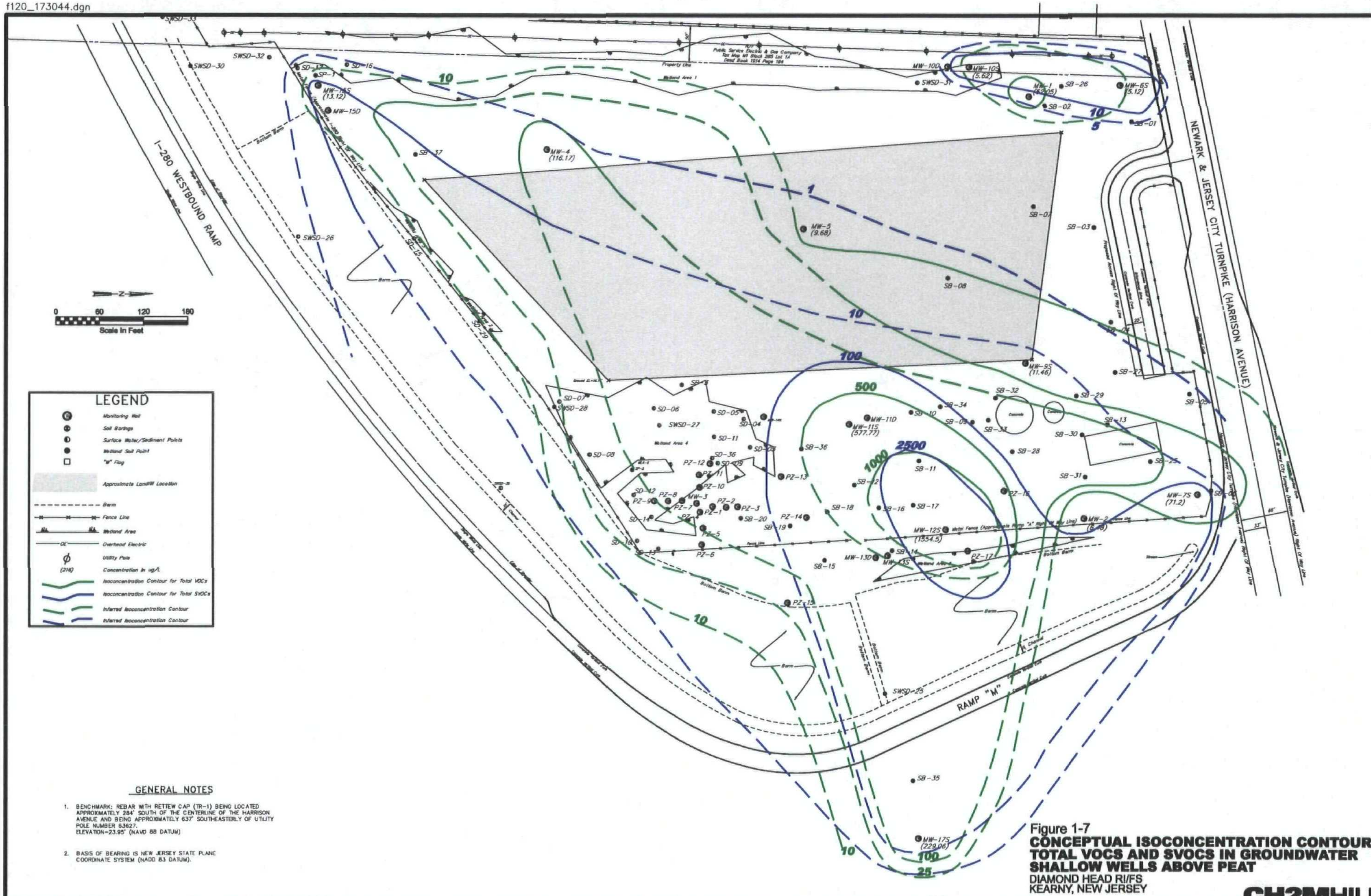

GENERAL NOTES

1. BENCHMARK: REBAR WITH RETTEW CAP (TR-1) BEING LOCATED APPROXIMATELY 284' SOUTH OF THE CENTERLINE OF THE HARRISON AVENUE AND BEING APPROXIMATELY 637' SOUTHEASTERLY OF UTILITY POLE NUMBER 63627.
ELEVATION=23.95' (NAVD 88 DATUM)

2. BASIS OF BEARING IS NEW JERSEY STATE PLANE COORDINATE SYSTEM (NADD 83 DATUM).

Figure 1-7
CONCEPTUAL ISOCONCENTRATION CONTOURS TOTAL VOCS AND SVOCS IN GROUNDWATER SHALLOW WELLS ABOVE PEAT
DIAMOND HEAD RI/FS
KEARNY, NEW JERSEY

CH2MHILL

400156

\\aphrodite\proj\USACE\359471DiamondHead\MapFiles\359471_OU2_RI-FS_Phase1\Figure 2-1 - Proposed Remedial Target Areas.mxd

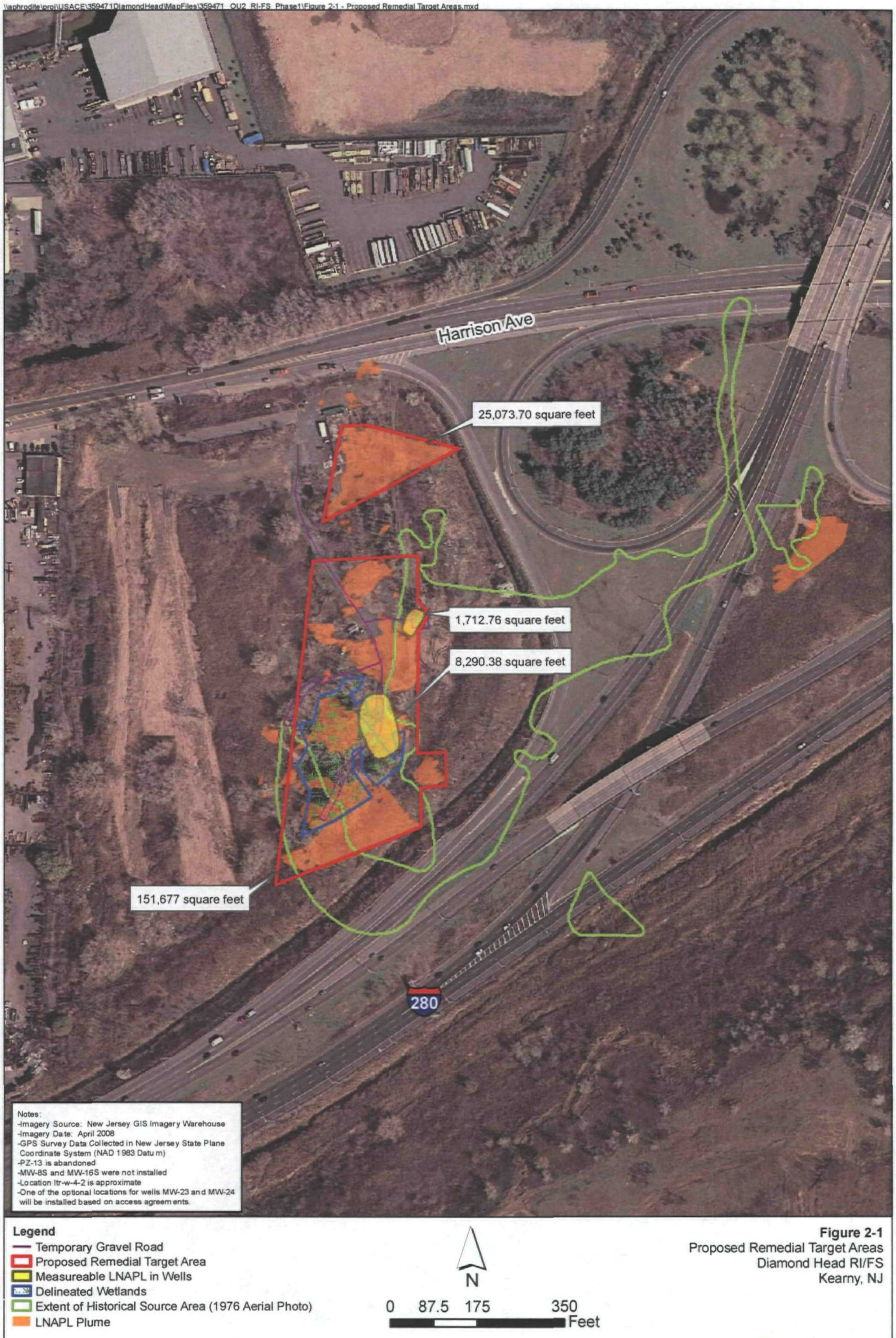

Figure 2-1
Proposed Remedial Target Areas
Diamond Head RI/FS
Kearny, NJ

Appendices

Appendix A

APPENDIX A

Supporting Information

This appendix contains the following supporting information:

Table A-1 Areas and Volumes of Various Wastes Within RTA
Table A-2 Volumes for Disposal and Clean Fill for Remedial Alternatives
Table A-3 Waste Water from the Construction and Operation of Remedial Alternatives
Table A-4 Estimated Maximum Vapor Emissions form Soil Excavation and Biocell Operations
Table A-5 Estimated Time to Construct Remedial Alternatives
Table A-6 Estimated PVSC and KMUA Fees
Excavation Support System Preliminary Design – Diamond Head Superfund Site (CH2M HILL Technical Memorandum)

The conceptual designs and costs for each alternative are based on the estimated quantities in the above tables.

Table A-1
Areas and Volumes of Various Wastes Within RTA
Diamond Head Oil Superfund Site, Kearny New Jersey

Waste	Area (SF)	Volume (CY)	Assumed Volume (CY)
Soil within areas with LNAPL (1)	10,003	2,593	2,600
Soil within rest of RTA	166,748	42,397	42,400
Concrete foundation	5,000	370	400
Concrete debris	25,074	464	500
Berm	24,000	8,889	8,900

(1) Voume of soil is based on average 7 ft depth.

Table A-2
Volumes for Disposal and Clean Fill for Remedial Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

Volumes		Alternative 2	Unit	Alternative 3	Unit	Alternative 4	Unit
Excavation							
	Soil within areas with LNAPL	2,600	CY	2,600	CY	2,600	CY
	Soil within rest of RTA	42,400	CY	42,400	CY	42,400	CY
	Concrete Foundation	400	CY	400	CY	400	CY
	Concrete Debris	500	CY	500	CY	500	CY
	Berm	8,900	CY	8,900	CY	8,900	CY
Offsite Disposal/Recycle							
	Soil within areas with LNAPL	2,600	CY	2,600	CY	2,600	CY
	Soil within rest of RTA	--	--	--	--	42,400	CY
	Concrete foundation	400	CY	400	CY	400	CY
	Concrete debris	500	CY	500	CY	500	CY
	LNAPL	59,500 (1)	gallons	59,500 (1)	gallons	59,500 (1)	gallons
	Filter cake	--	--	6,400 (2)	CY	--	--
Clean Fill Needed from Offsite Sources to Replace Followin Volumes							
	Soil within areas with LNAPL	--	--	2,600	CY	2,600	CY
	Soil within rest of RTA	--	--	--	--	42,400	CY
	Concrete foundation	--	--	400	CY	400	CY
	Concrete debris	--	--	500	CY	500	CY
	Filter cake	--	--	6,400	CY	--	--
	Total Clean Fill Needed	--	--	9,900	CY	45,900	CY

(1) Volume of LNAPL is assumed to be 2% of the volume of the water generated during dewatering of excavations. LNAPL assumed not to be genertated during biocell operation.

(2) Volume of filter cake is based on 15 % of the total volume of soil treated via soil washing.

Table A-3
Waste Water from the Construction and Operation of Remedial Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

RemedialAlternative / Source of Water	Water Volume (gallons)	Note
Alternative 2: Construction and Operation of Onsite Biocell		
Soil within excavation	2,972,851	Assumes that water content in RTA that can be dewatered is 32% based on RTA (volume of 46,000 CY[1]
Leakage through sheet pile walls and bottom native clay layer during excavation	171,306	Infiltration through sheet pile wall - 13.7 gal/day; infiltration through bottom clay - 938 gal/day. Assumed that water would be generated over the duration of construction of each cell, assumed to be 30 days/cell. Total is for the 6 cells within RTA.
Precipitation	444,000	Precipitation is based on 30,000 SF/cell and 4 inches per month of rainfall (0.33 ft/month). Total is for the 6 cells within RTA.
Subtotal during contruction	3,588,157	
Leakage through sheet pile walls and bottom native clay layer during biocell operation	10,422,575	Infiltration through sheet pile wall - 13.7 gal/day; infiltration through bottom clay - 938 gal/day. Assumed that water would be generated over the 5 years of operation. Total is for the 6 cells within RTA.
Subtotal during operation	10,422,575	
Total	14,010,732	
Alternative 3: Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soil		
Soil within excavation	2,972,851	Assumes that water content in RTA (volume 46,000 CY) is 47%[1]
Leakage through sheet pile walls and bottom native clay layer during excavation	171,306	Infiltration through sheet pile wall - 13.7 gal/day; infiltration through bottom clay - 938 gal/day. Assumed that water would be generated over the duration of construction of each cell, assumed to be 30 days/cell. Total is for the 6 cells within RTA.
Precipitation	444,000	Precipitation is based on 30,000 SF/cell and 4 inches per month of rainfall (0.33 ft/month). Total is for the 6 cells within RTA.
Soil Washing Modular System Blowdown	120,000	Assumes 15,000 gallon/month for 8-months of operation.
Total	3,708,157	
Alternative 4: Excavation and Offsite Disposal at TSDF		
Soil within excavation	2,972,851	Assumes that water content in RTA (volume 46,000 CY) is 47%[1]
Leakage through sheet pile walls and bottom native clay layer during excavation	171,306	Infiltration through sheet pile wall - 13.7 gal/day; infiltration through bottom clay - 938 gal/day. Assumed that water would be generated over the duration of construction of each cell, assumed to be 30 days/cell. Total is for the 6 cells within RTA.
Precipitation	444,000	Precipitation is based on 30,000 SF/cell and 4 inches per month of rainfall (0.33 ft/month). Total is for the 6 cells within RTA.
Total	3,588,157	

Note:

1. Assumes that the water content in the soil that can be removed is 32% (the total porosity is 47% and the water-filled porosity of the unstaturated soil is 15%).

2. Source: Office of the New Jersey State Climatologist, Rutgers University

400163

Table A-4
Estimated Maximum Vapor Emissions from Soil Excavation and Biocell Operations
Diamond Head Oil Superfund Site, Kearny New Jersey

			Soil Excavations									Biocell									
		Estimated Average Concentration in Soil	Soil Excavation Rate		Estimated Emissions per Hour	Estimated Emissions per Year	Reporting Threshold		Above reporting limit?	SOTA Threshold	Above reporting limit?	Air Flow Rate		Estimated Emissions per day	Estimated Emissions per hr	Estimated Emissions for year	Reporting Threshold		Above reporting limit?	SOTA Threshold	Above reporting limit?
Analyte	CAS Number	Vapor (0-7'bgs) (ug/L)	(yd^3/day)	(m^3/day)	(lbs/hour)	(lbs/yr)	(lbs/hour)	(lbs/yr)		(lbs/yr)		(cfm)	(m^3/day)	(lbs/day)	(lbs/hr)	(lbs/yr)	(lbs/hour)	(lbs/yr)		(lbs/hr)	
Acetone	67641	5,467	1,500	1,148	0.00	0.76	-	-	-	-	-	100	4,032	0.00	0.00	0.74	-	-	-	-	-
Benzene	71432	257,552	1,500	1,148	0.00	35.67	0.10	-	N	4000	N	100	4,032	0.10	0.00	34.82	0.10	-	N	4000	N
Carbon disulfide	75150	848,240	1,500	1,148	0.01	117.49	-	200	N	2000	N	100	4,032	0.31	0.01	114.67	-	200	N	2000	N
Carbon tetrachloride	56235	678,111	1,500	1,148	0.01	93.92	0.10	-	N	2000	N	100	4,032	0.25	0.01	91.67	0.10	-	N	2000	N
Chlorobenzene	108907	62,148	1,500	1,148	0.00	8.61	-	2000	N	10000	N	100	4,032	0.02	0.00	8.40	-	2000	N	10000	N
Chloroethane	75003	1,044,386	1,500	1,148	0.02	144.66	-	2000	N	10000	N	100	4,032	0.39	0.02	141.19	-	2000	N	10000	N
Chloroform	67663	215,627	1,500	1,148	0.00	29.87	0.10	-	N	1800	N	100	4,032	0.08	0.00	29.15	0.10	-	N	1800	N
Chloromethane	74873	1,431,994	1,500	1,148	0.02	198.34	-	2000	N	10000	N	100	4,032	0.53	0.02	193.59	-	2000	N	10000	-
Cyclohexane	110827	1,645,106	1,500	1,148	0.03	227.86	-	-	-	-	-	100	4,032	0.61	0.03	222.40	-	-	-	-	-
1,2-Dichlorobenzene	95501	39,684	1,500	1,148	0.00	5.50	-	-	-	-	-	100	4,032	0.01	0.00	5.36	-	-	-	-	-
1,3-Dichlorobenzene	741731	12,423	1,500	1,148	0.00	1.72	-	-	-	-	-	100	4,032	0.00	0.00	1.68	-	-	-	-	-
1,4-Dichlorobenzene	106467	8,219	1,500	1,148	0.00	1.14	-	600	N	6000	N	100	4,032	0.00	0.00	1.11	-	600	N	6000	N
Bromodichloromethane	75274	82,143	1,500	1,148	0.00	11.38	-	-	-	-	-	100	4,032	0.03	0.00	11.10	-	-	-	-	-
1,1-Dichloroethane	75343	363,410	1,500	1,148	0.01	50.33	-	200	N	2000	N	100	4,032	0.13	0.01	49.13	-	200	N	2000	N
1,2-Dichloroethane	107062	74,811	1,500	1,148	0.00	10.36	0.10	-	N	1600	N	100	4,032	0.03	0.00	10.11	0.10	-	N	1600	N
trans-1,2-Dichloroethylene	156605	528,747	1,500	1,148	0.01	73.24	-	-	-	-	-	100	4,032	0.20	0.01	71.48	-	-	-	-	-
1,1-Dichloroethylene	75354	746,208	1,500	1,148	0.01	103.36	-	80	Y	800	N	100	4,032	0.28	0.01	100.88	-	80	Y	800	N
cis-1,2-Dichloroethylene	156592	157,485	1,500	1,148	0.00	21.81	-	-	-	-	-	100	4,032	0.06	0.00	21.29	-	-	-	-	-
1,2-Dichloropropane	78875	151,195	1,500	1,148	0.00	20.94	-	200	N	2000	N	100	4,032	0.06	0.00	20.44	-	200	N	2000	N
Ethylbenzene	100414	611,007	1,500	1,148	0.01	84.63	-	2000	N	10000	N	100	4,032	0.23	0.01	82.60	-	2000	N	10000	N
Hexanone-2	591786	2,335	1,500	1,148	0.00	0.32	-	-	-	-	-	100	4,032	0.00	0.00	0.32	-	-	-	-	-
Isopropylbenzene	98828	132,140	1,500	1,148	0.00	18.30	-	2000	N	10000	N	100	4,032	0.05	0.00	17.86	-	2000	N	10000	N
Methyl acetate	79209	6,032	1,500	1,148	0.00	0.84	-	-	-	-	-	100	4,032	0.00	0.00	0.82	-	-	-	-	N
Methyl bromide	74839	641,807	1,500	1,148	0.01	88.90	-	2000	N	10000	N	100	4,032	0.24	0.01	86.76	-	2000	N	10000	N
Methylene chloride	75092	216,846	1,500	1,148	0.00	30.03	-	2000	N	10000	N	100	4,032	0.08	0.00	29.32	-	2000	N	10000	N
Methyl cyclohexane	108872	8,221,900	1,500	1,148	0.13	1,138.79	-	-	-	-	-	100	4,032	3.05	0.13	1,111.50	-	-	-	-	-
Methyl ethyl ketone	78933	11,614	1,500	1,148	0.00	1.61	-	2000	N	10000	N	100	4,032	0.00	0.00	1.57	-	2000	N	10000	N
Methyl isobutyl ketone	108101	12,005	1,500	1,148	0.00	1.66	-	2000	N	10000	N	100	4,032	0.00	0.00	1.62	-	2000	N	10000	N
Styrene	100425	15,932	1,500	1,148	0.00	2.21	-	200	N	2000	N	100	4,032	0.01	0.00	2.15	-	200	N	2000	N
1,1,2,2-Tetrachloroethane	79345	11,231	1,500	1,148	0.00	1.56	-	60	N	600	N	100	4,032	0.00	0.00	1.52	-	60	N	600	N
Tetrachloroethylene	127184	715,505	1,500	1,148	0.01	99.10	0.10	-	N	10000	N	100	4,032	0.27	0.01	96.73	0.10	-	N	10000	N
Toluene	108883	1,758,539	1,500	1,148	0.03	243.57	-	2000	N	10000	N	100	4,032	0.65	0.03	237.73	-	2000	N	10000	N
1,2,4-Trichlorobenzene	120821	2,235	1,500	1,148	0.00	0.31	-	2000	N	10000	N	100	4,032	0.00	0.00	0.30	-	2000	N	10000	N
1,1,1-Trichloroethane	71556	579,805	1,500	1,148	0.01	80.31	-	2000	N	10000	N	100	4,032	0.21	0.01	78.38	-	2000	N	10000	N
1,1,2-Trichloroethane	79005	46,023	1,500	1,148	0.00	6.37	0.10	-	N	2000	N	100	4,032	0.02	0.00	6.22	0.10	-	N	2000	N
1,1,2-Trichloro-1,2-trifluoroethane	76131	19,947,739	1,500	1,148	0.32	2,762.91	-	-	-	-	-	100	4,032	7.39	0.31	2,696.70	-	-	-	-	-
Trichloroethylene	79016	901,196	1,500	1,148	0.01	124.82	0.10	-	N	10000	N	100	4,032	0.33	0.01	121.83	0.10	-	N	10000	N
Trichlorofluoromethane	75694	8,135,297	1,500	1,148	0.13	1,126.80	-	-	-	-	-	100	4,032	3.01	0.13	1,099.80	-	-	-	-	-
Vinyl chloride	75014	1,304,858	1,500	1,148	0.02	180.73	-	40	Y	400	N	100	4,032	0.48	0.02	176.40	-	40	Y	400	N
m-Xylene	108383	3,019,851	1,500	1,148	0.05	418.27	-	2000	N	10000	N	100	4,032	1.12	0.05	408.25	-	2000	N	10000	N
o-Xylene	95476	2,348,923	1,500	1,148	0.04	325.34	-	2000	N	10000	N	100	4,032	0.87	0.04	317.55	-	2000	N	10000	N
p-Xylene	106423	3,282,711	1,500	1,148	0.05	454.68	-	2000	N	10000	N	100	4,032	1.22	0.05	443.78	-	2000	N	10000	N
Total VOCs		60278491.95																			

Notes:
Phase 1 soil concentrations were averaged for each compound from samples collected within the RTA boundaries in the 0-7'bgs interval.
Soil excavation rates represent maximum soil removal rates during all alternatives
Air flow rates represent maximum air flow expected during biocell operation
- Denotes no reporting thrshold or reporting limit

400164

Table A-5
Estimated Time to Construct Remedial Alternatives
Diamond Head Oil Superfund Site, Kearny New Jersey

Remedial Alternative	Number of week to complete	Assumptions
Alternative 2: Construction and Operation of Onsite Biocell		
Initial dewatering	2	Assuming 200 gpm
Excavation	10	Excavate areas with LNAPL soil, rest of RTA, concrete foundation, concrete debris, and berm at 1,000 CY/day.
Loadout	1	Loadout with LNAPL soil, concrete foundation, and concrete debris assuming 22 tons/truck, 50 trucks/day.
Biocell Construction	20	
Backfill	10	Backfill clean fill to replace the soil volume of LNAPL, rest of RTA, concrete foundation, concrete debris, and berm at 1,000 CY/day.
Total	43	Assume less than 1 year in conceptual design.
Alternative 3: Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soil		
Initial dewatering	2	Assuming 200 gpm
Excavation	10	Excavate areas with LNAPL soil, rest of RTA, concrete foundation, concrete debris, and berm at 1,000 CY/day.
Loadout	1	Loadout with LNAPL soil, concrete foundation, and concrete debris assuming 22 tons/truck, 50 trucks/day.
Backfill	10	Backfill clean fill to replace the soil volume of LNAPL, rest of RTA, concrete foundation, concrete debris, and berm at 1,000 CY/day.
Soil Washing	31	Assuming to process 20 TPH, 20 hr/day, 6 days/week.
Total	54	Assume 1 year in conceptual design.
Alternative 4: Excavation and Offsite Disposal at TSDF		
Initial dewatering	2	Assuming 200 gpm
Excavation	10	Excavate areas with all RTA soil, concrete foundation, concrete debris, and berm at 1,000 CY/day.
Loadout	12	Loadout with all RTA soil, concrete foundation, and concrete debris assuming 22 tons/truck, 50 trucks/day.
Backfill	10	Backfill clean fill to replace the soil volume of all RTA soil, concrete foundation, concrete debris, and berm at 1,000 CY/day.
Total	34	Assume 8 months in conceptual design.

400165

Table A-6
Estimated Fees for Discharge to PVSC and KMUA
Diamond Head Oil Superfund Site, Learny, NJ

	Quantity	Rate	Charge
Alternative 2			
PVSC			
Connection fees			
Application for permit			750
Application for letter of authorization			750
Total			1,500
During construction			
Annual charge			
Charge for non-categorical discharge			1,500
Letter of authorization			200
Pollution prevention inspection			125
Subtotal			1,825
Discharge charge			
User charge rate for volume per million gallons	4	527	1,897
User charge rate for BOD per 1000 pds	0.19	324	62
User charge rate for TSS per 1000 pds	0.23	351	82
Volume discharge fee per gallon	3,588,157	0.003	10,764
Subtotal			12,806
Total			14,631
During 5 years of operation ($ reflect annual charge)			
Annual charge			
Charge for non-categorical discharge			1,500
Letter of authorization			200
Pollution prevention inspection			125
Subtotal			1,825
Suntotal for 5 years			9,125
Discharge charge			
User charge rate for volume per million gallons	11	527	5,534
User charge rate for BOD per 1000 pds	0.56	324	181
User charge rate for TSS per 1000 pds	0.68	351	237
Discharge fee per gallon	10,400,000	0.003	31,200
Subtotal for 5 years			37,151
Total			46,276
KMUA			
During construction			
Fee per 300 gal/day	33	1914	62,719
Fee $6.95/100cu feet	4,797	6.95	33,339
Total			96,058
During 5 years of operation			
Fee per 300 gal/day	95	1914	181,786
Fee $6.95/100cu feet	13,904	6.95	96,631
Total			278,417

SUMMARY	PVSC	KMUA
During construction	16,131	96,058
During 5 years of operation	46,276	278,417

Alternative 3			
PVSC			
Connection fees			
Application for permit			750

Table A-6
Estimated Fees for Discharge to PVSC and KMUA
Diamond Head Oil Superfund Site, Learny, NJ

	Quantity	Rate	Charge
Application for letter of authorization			750
Total			1,500
During construction			
Annual charge			
Charge for non-categorical discharge			1,500
Letter of authorization			200
Pollution prevention inspection			125
Subtotal			1,825
Discharge charge			
User charge rate for volume per million gallons	4	527	1,897
User charge rate for BOD per 1000 pds	0.20	324	64
User charge rate for TSS per 1000 pds	0.24	351	84
Volume discharge fee per gallon	3,708,157	0.003	11,124
Subtotal			13,170
Total			14,995
KMUA			
During construction			
Fee per 300 gal/day	34	1914	64,817
Fee $6.95/100cu feet	4,957	6.95	34,454
Total			99,271
SUMMARY	PVSC	KMUA	
During construction	16,495	99,271	

Alternative 4			
PVSC			
Connection fees			
Application for permit			750
Application for letter of authorization			750
Total			1,500
During construction			
Annual charge			
Charge for non-categorical discharge			1,500
Letter of authorization			200
Pollution prevention inspection			125
Subtotal			1,825
Discharge charge			
User charge rate for volume per million gallons	4	527	1,897
User charge rate for BOD per 1000 pds	0.19	324	62
User charge rate for TSS per 1000 pds	0.23	351	82
Volume discharge fee per gallon	3,588,157	0.003	10,764
Subtotal			12,806
Total			14,631
KMUA			
During construction			
Fee per 300 gal/day	33	1914	62,719
Fee $6.95/100cu feet	4,797	6.95	33,339
Total			96,058
SUMMARY	PVSC	KMUA	
During construction	16,131	96,058	

Appendix B

APPENDIX B

Conceptual Design Alternative 2 – Construction and Operation of Onsite Biocell

Alternative Description

Alternative 2 relies on the construction of an onsite biocell to create a favorable environment for biological degradation of the principal threat LNAPL in order to achieve the PRGs within the RTA. The alternative consists of the excavation of soil within the RTA, amending the soil with bioenhancing nutrients, constructing an onsite biocell, backfilling, providing oxygen to promote aerobic biodegradation processes, and monitoring performance throughout the active operating period (estimated to be between 3 to 8 years and assumed to be 5 years for the purpose of this FFS).

The bioremediation technology relies on creating and maintaining a favorable environment for indigenous microorganisms to use contaminants such as LNAPL as a carbon food source. Groundwater samples collected during the Phase 2 RI have shown the presence of petroleum consuming microorganisms located within the RTA. The biocell would be designed to enhance the activity of these microorganisms by delivering subsurface nutrients to stimulate increased microorganism growth and consumption of contaminates as a food source. The basic requirements for enhanced bioremediation include a food source (LNAPL), oxygen, and nutrients such as nitrogen, phosphorous, and potassium.

In Alternative 2, the RTA would be divided into six separate treatment cells with construction of the cells completed sequentially (one cell at a time). Specifically, a sheet pile wall would be used to isolate a cell, support the excavation side walls and minimize the infiltration of groundwater during the excavation. A rubber gasket would be used at the sheet pile joints to minimize infiltration. As excavation of the soil within the cell proceeds, the excavation would be dewatered and the water treated before discharge through a sewer connection (constructed as part of the alternative) to a public sewer leading to the PVSC treatment plant. Based on review of the Phase 1 groundwater data relative to PVSC discharge requirements, oil-water separation and settlement for TSS are the treatment processes included before discharge of the water.

Excavated soil would be screened from large debris, stockpiled at the site, and blended with a bulking agent such as woodchips to increase the porosity of the soil. A soluble mixture of nutrients (nitrogen, phosphorous, and potassium) would be added to the soil to achieve desired nutrient concentrations. The soil would be homogenized by use of an excavator and placed back into each cell.

Before placing the soil, an air delivery system would be installed on top of the native clay layer in each cell in order to supply adequate oxygen (through injected air) to the microbial population. The air delivery system would be installed within a distribution sand layer in a grid like pattern using slotted piping. Amended soil would be backfilled on top of the air

400169

distribution sand layer, and a second piping system would be installed within a sand layer above the amended soil to collect air from or supply nutrients to the biocell. Each cell would be capped with a plastic liner and covered with a sand drainage layer to draw excess precipitation away from the biocell.

During biocell operation, oxygen (via air injection) would be delivered to each cell in 4-6 hour alternating cycles. Groundwater infiltration through the sheet pile wall and native base clay layer would keep the soil moist and additional water, if needed, would be distributed to the amended soil through the nutrient delivery system. A pump would be installed in a sump within each cell to remove the water that is anticipated to collect in the cells from leakage through the sheet pile wall and from the underlying clay. The water would be pumped to the onsite treatment system and discharged to the PVSC treatment plant.

Two monitoring wells would be installed in each biocell following its construction. During operation when the biocells are maintained void of groundwater, the monitoring wells will be used to collect vapor samples. The vapor samples will be collected monthly and field screened to determine the concentrations of carbon dioxide, oxygen, and VOCs. These results will be interpreted to assess whether biodegradation is occurring, and changes may be made based on the results to optimize the performance of the biocells (e.g. nutrient addition, water addition, increase or decrease in air delivery, etc.). Respiration tests will be conducted once vapor samples suggest that biological activity is decreasing. The respiration test will interrupt biocell operation for 1 to 2 weeks and therefore, are estimated to be conducted only once per year. Respiration tests will provide information on biodegradation rates, and will be use to determine how much longer the biocell will be required to operate. If respiration results show a decrease in biological activity, additional nutrient dosages may be delivered to the amended soil through the nutrient delivery system. If tests continue to show decreased biological activity after optimization steps are exhausted, PRGs will likely have been achieved, biocell operation will be discontinued, and confirmation soil sampling will be performed. Soil sampling may also be conducted periodically during biocell operation by driving a probe through the top liner and into the biocell soil.

Once soil samples suggest that PRGs may have been attained within the biocell, a decision will be made to discontinue biocell operation, the biocell will be flooded with water through the nutrient delivery system. Once water levels have stabilized in the cells, groundwater samples for laboratory analysis will be collected from each well to confirm that the PRGs were met and the wells will be checked for the presence of LNAPL.

Treatability testing will need to be performed prior to full scale implementation to determine optimal nutrient dosages and delivery rates in treating the soil to the established PRGs. Based on this testing, soil amendments and nutrients delivery specifications needed to achieve optimum biodegradation will be determined.

Minimal waste streams are expected to be generated for offsite disposal. The waste streams expected from this alternative include:

- Water from dewatering activities to be discharged through a public sewer to PVSC
- LNAPL separated from the water from dewatering activities to be recycled or disposed at an offsite disposal facility
- Concrete foundations and other large debris within the RTA to be recycled or disposed at offsite disposal facility
- Soil from the two areas where LNAPL was observed in monitoring wells

The duration of construction of this alternative is anticipated to require less than 1 year with biocell operation continuing for an additional estimated 3 to 8 years (assumed as 5 years for the purpose of estimating the costs in this FFS). Actual construction duration may be shorter as some activities can be scheduled to proceed in parallel. The estimated duration is based on the following:

Activity	Duration
Initial Dewatering	2 weeks
Excavation	10 weeks
Loadout	1 weeks
Biocell Construction	20 weeks
Backfill	10 weeks
Biocell Operation	Estimated 3-8 years, assumed to be 5 years for the purpose of estimating costs in this FFS

Conceptual Design

Figure B-1 shows the RTA, the conceptual layout of the cells in which the excavation would proceed, the configuration of subsurface piping, and where treatment facilities may be situated at the site. Figure B-2 is a cross section showing the conceptual biocell component layout.

Alternative 2 would include a temporary treatment building to house nutrient delivery and air delivery systems, a network of delivery piping installed within subsurface distribution sand layers, and an onsite wastewater treatment plant.

The design basis for Alternative 2 developed for this FFS is provided below.

Pre-design investigation

- Conduct an investigation to define the RTA boundaries. This investigation is assumed to be of similar scope to the Phase 2 RI investigation. If LIF is used to define the RTA boundary, test pitting within the berm would be needed to determine berm contents and whether LIF can be applied through the berm.
- Conduct pre-design investigation for waste characterization purposes to characterize soil and concrete for disposal/recycling purposes.
- Sample soil berm to determine if the existing soil can be re-used to replace the removed berm at the end of remedial activities.

Remedial Design

- Complete the full-scale system design and procure subcontractors for its installation; coordinate with various entities (e.g., POTW PVSC and NJDEP).
- Perform treatability bench/pilot scale testing to determine most effective operating parameters (including air flow rates, nutrient types and doses).

Pre-Remediation Site Work

- Clear vegetation east and north of the landfill to accommodate operations, locating facilities, and constructing temporary access roads. Estimated area of 480,000 SF.

- Construct sewer connection from the proposed onsite wastewater treatment facility to the KMUA/PVSC sewer system located at the intersection of Harrison and Bergen Ave. Sewer size 750 ft length of 8 inch diameter pipe.
- Create an onsite water source by connecting to the 24 inch water main located on the southern side of Harrison Ave. Pipe size 400 ft length of 2 inch diameter pipe.
- Construct temporary access roads, turnaround area, and a lay-down area (assumed 6 inches of gravel) to support onsite construction vehicles and remedial facilities. Estimated area of 67,100 SF.

Soil Excavation

- Install isolation sheet pile system around the entire RTA perimeter, and between each cell. Length of sheet piling is estimated at 4,300 ft to a depth of 35 ft bgs. This includes a sheet pile wall around the perimeter of the RTA and dividers between the cells of the biocell as well as a sheet pile wall to support the excavation of the two areas where LNAPL is found in monitoring wells (3,700 ft and 600 ft, respectively).
- Excavate and stockpile 24,000 SF of the approximately 10 ft high soil berm, and stage onsite in stockpiles. Estimated volume approximately 8,900 CY.
- Excavate concrete foundations within RTA - assumed concrete foundations cover a total of approximately 100 ft by 50 ft with an assumed thickness of 24 inches. In addition, we have assumed 500 CY of miscellaneous concrete debris in the northern triangular RTA. Concrete and debris will be transported for offsite disposal/recycling. Estimated volume 900 CY.
- Excavate soil within areas containing measureable LNAPL thickness in wells – estimated 10,000 SF to average depth of 7 ft bgs. LNAPL impacted soil will undergo onsite stabilization in preparation for offsite transportation and disposal. Estimated volume 2,600 CY.
- Excavate and stockpile soil within remainder of RTA - 166,800 SF to average depth of 7 ft bgs. Estimated volume 42,400 CY.
- Excavation is assumed to proceed sequentially in each cell, approximately 30,000 SF each.

Dewatering

- Dewater each treatment cell prior to and during excavation and treat as described below. Dewatering of the RTA is estimated to require approximately 2 weeks (assume 200 gpm dewatering rate).
- Initial water volume from dewatering RTA is estimated at 2,972,900 gallons.
- Water volume from leakage through sheet pile walls and native clay layer during construction for entire RTA is estimated at 171,300 gallons and water volume from rainwater is estimated at 444,000 gallons.
- Total water volume is estimated at 3,588,200 gallons during construction.
- Total water volume accumulated in treatment cells during estimated 5 years of biocell operation estimated at 10,422,600 based on estimated leakage through the sheet pile wall and the native clay layer or approximately 4 gpm.

Treatment and Disposal of Water from Dewatering

- Treat water from dewatering of excavations and biocell operations using modular treatment system that would consist of:
  - Oil / water separator - size for effective oil and grease removal at a design flow of 200 gallons per minute for water and 10 gallons per minute for LNAPL.

  - Settlement tank(s) - size for effective TSS settlement to provide appropriate residence time in relation to the maximum flow rate and meet typical PVSC TSS criteria (250ml/L) is estimated to be two 5,000 gallon polypropylene tanks.
- Discharge treated effluent to KMUA/PVSC via sewer connection.
- Sample treated effluent to monitor compliance with PVSC requirements.

Construction of Bioremediation Cells

- Prepare excavated soil by homogenizing and mixing with a bulking agent assumed to be wood chips, total volume of soil requiring treatment for all 6 cells is 42,400 CY. This volume will increase to 70,800 CY as a result of adding the bulking agent. Mixing would be accomplished in small batches.
- Install non-woven geotextile on top of exposed clay (bottom layer of the biocell) – estimated at 176,800 SF.
- Install air distribution piping: 2 inch diameter perforated PVC piping to be installed in a 12 inch pea gravel distribution layer. Piping installed in a grid layout with 30 ft spacing between each pipe in order to achieve a width of influence of 15 ft on either side of the distribution pipe. Non-perforated 2 inch diameter PVC piping will be installed in a 3 foot deep trench to connect the perforated air distribution piping to the air blower located within the treatment building. Total length of PVC perforated piping 5,300 ft. Total length of PVC non-perforated piping 1,900 ft.
- Install 176,800 SF of non-woven geotextile on top of pea gravel.
- Place amended soil on top of geotextile to the design height of 7 – 8 ft ags (above ground surface). This elevation accounts for adding 2 feet for the piping sand layers and the addition of bulking material.
- Install 176,800 SF of non-woven geotextile on top of amended soil.
- Install air collection/nutrient delivery piping: 2 inch diameter perforated PVC piping to be installed in a 12 inch sand distribution layer. Same arrangement and piping lengths as above.
- Install 176,800 SF of non-woven geotextile on top of sand.
- Install176,800 SF of 60 mil HDPE flexible membrane liner (FML) on top of geotextile.
- Install sand drainage layer on top of FML (6 inches thick), and vegetative support layer (6 inches think) on top of sand.
- Following backfilling and during biocell construction, install 2 groundwater monitoring wells in each cell. Wells will penetrate the liner using FML boots so that the linter integrity is maintained.
- Seed and mulch to create grassy cover.

Water Collection and Nutrient Delivery Systems Within Biocell

- Install collection system for water accumulated in biocell. System consists of a submersible pump placed in a sump located in the south western corner of each cell for a total of 6 pumps. Each sump will be connected via 2 inch HDPE pipe to the onsite modular treatment system. Total length of piping estimated at 1,000 ft. Note that surface runoff over the area of the biocell will be over the uncontaminated soil cover. This flow may be either allowed to flow through sheet flow to the remainder of the site or be directed via a storm sewer to the drainage culvert.
- Install an insulated remediation building with water, sanitation, electrical service, lights, HVAC, etc.
- Install air distribution blower (2 blowers each 400 scfm capacity at 10 psi, supply air flow at 400 cfm). Blowers can be used to inject air into the air distribution system, extract from the air collection system, or do both simultaneously.

- Install nutrient delivery equipment including delivery pump (10 gpm at 50 psi) and mixing tank (500 gallon).

Soil Backfill and Compaction
- Backfill and compact. Note that import of clean soil is not needed because reduction in volume as a result of offsite disposal of concrete debris and soil from two areas with LNAPL in monitoring wells will be offset by volume of augmentation material added to soil before it is placed back into biocell.
- Replace berm that needed to be excavated to construct biocell with the same soil to pre-remedial dimensions (assumed that following supplemental pre-design investigation, the material is found to be of acceptable characteristics).

Transportation and Offsite Disposal of Other Wastes
- Transport for offsite disposal/recycling concrete foundations and building debris – estimated concrete volume is 900 CY, assumed non hazardous.
- Transport for offsite disposal approximately 2,600 CY of soil excavated from 2 areas where measurable product thickness is observed in wells, assumed non hazardous. Treat soil via stabilization before sending for offsite disposal.
- Transport for offsite disposal/recycling 59,500 gallons of LNAPL separated from water during dewatering, assumed non hazardous.
- Dispose of/recycle above waste streams in RCRA-permitted facilities (subtitle D).

Operation and Maintenance:
- Operate the air distribution system, manifolded to the 6 cells with automatic switching so that only 1 cell is operated at a time for a brief period (4 – 6 hrs).
- Install a Programmable Logic Controller (PLC) and telemetry system to enable automated operation of the air distribution system.
- Deliver intermittently nutrients – 4 doses assumed. During nutrient delivery, air distribution would be shut down. Nutrients delivered are based on the following by volume: .015% nitrogen, .001% phosphorous, and .005 % potassium.
- Inspect and maintain surface cover on a weekly basis, cut vegetation weekly during the summer.
- Monitor system performance and operation
  - Collect samples from vapor effluent for field screening (monthly) and for laboratory analysis (annual).
  - Collect required effluent samples from modular treatment system (quarterly).
  - Collect soil samples periodically (1/year) based on vapor results to verify that the PRGs have been achieved.
  - Submit quarterly monitoring reports to PVSC.

Verification Sampling and 5-year reviews
- Monitor vapor from dry monitoring wells and once VOCs concentrations are low, conduct respiration testing (annually at a minimum). Once respiration test results indicate low biological activity, collect subsurface soil samples using direct-push technology through the liner, and have soil samples analyzed for indicator compounds.
- Once vapor and soil samples suggest PRGs have been achieved, discontinue operation of water collection system and flood the cells with clean water (may require several months).
- Sample soil and groundwater from monitoring wells, monitor for the presence of LNAPL and analyze samples for selected parameters. Assume 3 events to confirm.

- Perform one 5-year review.

Closure

- Pull the sheet piles and remove from the site.
- This alternative assumes that all biocell components will be left in place for potential future use as part of the overall remedy of the site.

Of note, air emissions from the biocell operation activities were estimated in order to evaluate the various regulatory requirements that may affect alternative implementation. The analytical soil results collected during the Phase 1 investigation were used to estimate an average concentration for detected VOCs. The average concentration was calculated based on detected VOC concentrations within the vertical and horizontal limits of the RTA. The partitioning calculations performed using these average concentrations suggest that VOC emissions during excavation activities would be below the NJDEP reporting thresholds with the exception of the emissions of 1,1-Dichloroethylene and vinyl chloride. The partitioning calculations suggest that all VOC emissions would be below the NJDEP SOTO levels and as such may not require emissions controls but will require monitoring. This will be verified during the remedial design when the emissions will be estimated for the final RTA footprint and the request for determination or a permit application (as applicable) would be prepared and submitted to the NJDEP. This FFS assumes that emissions controls would not be required (including for emissions from combustion equipment operated at the site).

Estimated Costs

The capital, O&M, periodic, and present worth costs for Alternative 2 are summarized in the table below. The detailed cost elements are provided in Table B-1.

	Estimated Present Worth Costs	Occurs in Year
Capital Cost	$16,081,665	Year 0
O&M Cost (1)	$1,237,312	Years 1 - 6
Periodic Cost	$19,875	
Total Cost	$17,338,852	--

(1) The annual O&M costs (not present worth) are estimated at $207,000.

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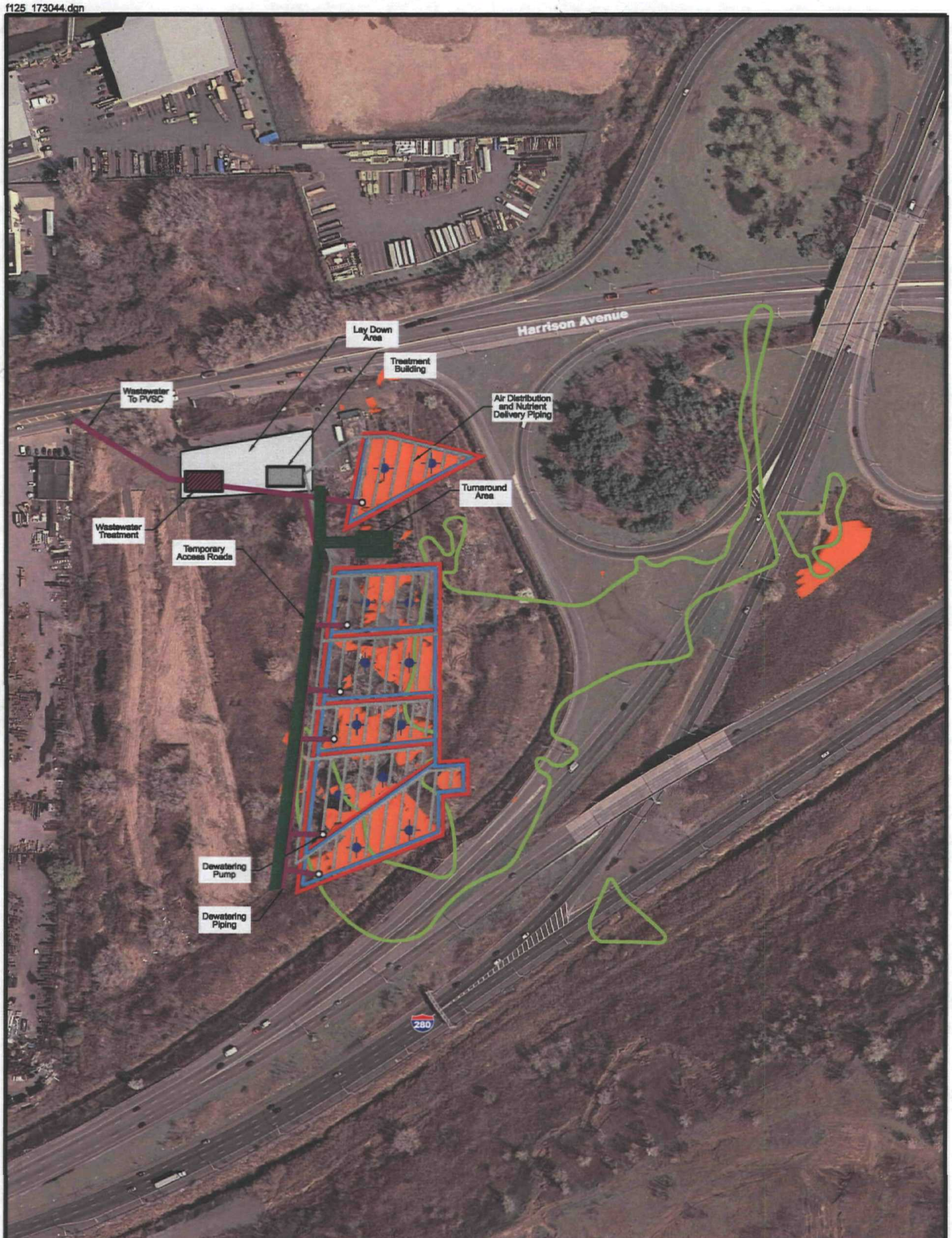

Legend

- Groundwater Monitoring Well
- Dewatering and Treatment Piping
- Temporary Access Road
- Air Distribution and Nutrient Delivery Piping
- Gravel Paved Area
- Remedial Treatment Area
- Turnaround Area
- Dewatering Sump
- Sheet Piling
- Extent of Historical Source Area (1976 Aerial Photo)
- LNAPL Plume

0 200 400

Figure B-1
Plan View - Construction and Operation of Onsite Biocell
Diamond Head - Focused FS
Kearny, New Jersey

CH2MHILL

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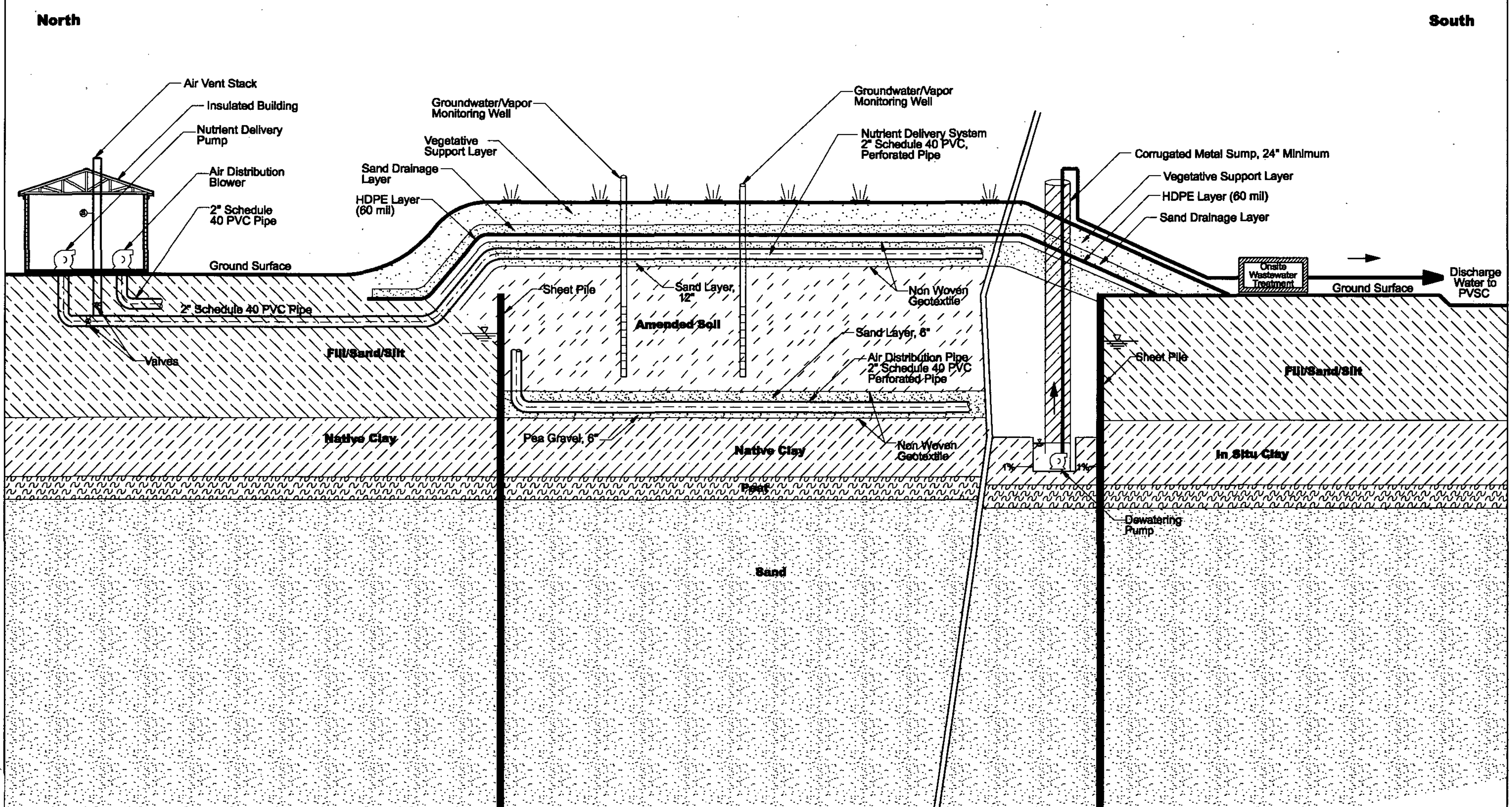

Table B-2
Construction and Operation of Onsite Biocell Conceptual Cross Section
Diamond Head - Focused FS
Kearny, New Jersey

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TABLE B-1 Alternative 2 **COST ESTIMATE SUMMARY**

CONSTRUCTION AND OPERATION OF ONSITE BIOCELL

Site:	Diamond Head Oil Superfund Site	**Description:**	Alternative 2 consists of excavation of contaminated soil, construction of an onsite biocell, onsite backfilling of amended soil, and operation & monitoring of the constructed biocell. Excavated soil from the two areas where LNAPL is found in monitoring wells will be disposed of at an off-site TSDF. The project duration is anticipated to be 6 years. Capital costs occur in Year 0-1. Annual O&M costs occur in Years 1-6. Periodic costs occur in Year 6.
Location:	Kearny, New Jersey		
Phase:	Feasibility Study (-30% to +50%)		
Base Year:	2009		
Date:	June 4, 2009		

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
1 Mobilization/Demobilization					
Construction Equipment & Facilities	1	LS	$80,000	$80,000	
Submittals/Implementation Plans	1	LS	$15,000	$15,000	Work plan, health and safety plan, permits, etc.
Temporary Facilities	12	MO	$1,000	$12,000	Office trailers, storage facilities, sanitary facilities.
Post-Construction Submittals	1	LS	$15,000	$15,000	
SUBTOTAL				$122,000	
2 Pre-Remediation Site Work					
Clearing and Grubbing	11	AC	$3,000	$33,000	See assumptions
Fencing/Signs/Gates	440	LF	$20	$8,800	Assumes 10% of the perimeter of the site will require new fencing, signs, and gates.
Construction of Sewer Connection	750	LF	$95	$71,250	See assumptions
Construction of Water Connection	400	LF	$65	$26,000	See assumptions
Construction of Temporary Electric Service	1	LS	$25,000	$25,000	Estimate
Construction of Temporary Roads and Gravel Lay Down	67,110	SF	$0.90	$60,399	6 in thick gravel, see assumptions.
SUBTOTAL				$224,449	
3 LNAPL Impacted Soil Excavation					
Sheet Pile Installation	21,000	SF	$44	$924,000	For 2 impacted areas, approximate 600 ft by 35 ft deep. Vendor quote from Ratto Construction.
Excavation and Hauling	2,600	CY	$15	$39,000	
Transportation and Disposal	4,160	TON	$82	$339,456	Vendor quote from Lewis Environmental. Cost includes price of stabilization.
Characterization sampling	3	EA	$600	$1,800	Vendor quote indicates 1 composite sample per 1,600 tons.
LNAPL Sheet Pile Removal	21,000	SF	$4	$84,000	Vendor quote from Ratto Construction.
SUBTOTAL				$1,388,256	
4 Building Foundation Excavation					
Concrete Foundation Demolition	400	CY	$65	$26,000	
Concrete Foundation and Rubble Excavation and Hauling	900	CY	$25	$22,500	See assumptions.
Transportation / Recycle Material	1,440	TON	$16	$23,040	Vendor quote from Lewis Environmental.
SUBTOTAL				$71,540	
5 Onsite Soil Berm Excavation					
Excavation and Hauling	8,900	CY	$12	$106,800	See Assumptions.
Stockpiling	8,900	CY	$5	$44,500	
SUBTOTAL				$151,300	
6 Dewatering					
Dewatering /Leachate Sump Pumps	1	LS	$13,600	$13,600	Purchase of six sump pumps operating at 50 gpm
2" HDPE Trenching and Piping	1,000	FT	$18	$18,000	1000' of leachate piping. Includes cost for trenching of pipe. MEANS cost data.
SUBTOTAL				$31,600	
7 Wastewater Treatment (for dewatering water)					
Purchase Treatment System	1	LS	$44,100	$44,100	Vendor quote from Maple Leaf Environmental. Includes mobilization costs.
Equipment Repair and Parts	1	LS	$10,000	$10,000	
SUBTOTAL				$54,100	
8 Construction of Bioremediation Cells					
Sheet Pile Design and Installation	129,500	SF	$44	$5,698,000	See Assumptions
Excavation and Hauling of RTA Soil	42,400	CY	$15	$636,000	Assumes RTA volume minus LNAPL impacted soils, building foundation, and concrete rubble and to a depth of 7 ft bgs.
Stockpile RTA Soil	42,400	CY	$5	$212,000	
2" Air Distribution Perforated Pipe	5,312	FT	$28	$148,736	See assumptions
6" Air Distribution Gravel Layer	3,273	CY	$30	$98,195	Volume=RTA area with 0.5 ft thickness of material.
6" Air Distribution Sand Layer	3,273	CY	$20	$65,463	Volume=RTA area with 0.5 ft thickness of material.
Air Distribution Non-Woven Geotextile	353,502	SF	$0.25	$88,376	Assumes one layer below and above distribution sand/gravel layer. MEANS Cost Data.
Addition of Wood Chips to Treatment Soil and Place Into	28,408	CY	$15	$426,120	Assume a ration of 3:2 (soil: bulking agent).
2" Nutrient Delivery System Perforated Pipe	5,312	LF	$8	$42,496	See assumptions
12" Nutrient Delivery System Sand Layer	6,546	CY	$20	$3,273	Volume=RTA area with 1 ft thickness of material.
Nutrient Delivery System Non-Woven Geotextile	353,502	SF	$0.50	$282,802	Assumes one layer below and above nutrient delivery system sand layer
HDPE Liner Above Nutrient Delivery System	176,751	SF	$0.80	$141,401	Assumes entire RTA to be covered, 60 mil HDPE.
Leachate Drainage Sand Layer	3,273	CY	$20	$65,463	Assumes 6 in layer over RTA.
Vegetative Support Layer	3,273	CY	$30	$98,195	Assumes 6 in layer over RTA.
Seed and Mulch	4	AC	$2,500	$10,000	Seed and mulch over entire RTA.
Misc Valves and Fittings	1	LS	$10,000	$10,000	
SUBTOTAL				$8,026,520	
9 Bioremediation Delivery System From Treatment Building to Cells					
Steel Building 24' x 24'	1	LS	$70,000	$70,000	Insulated building.
Concrete Slab 28' x 28' x 6"	784	SF	$7	$5,488	Wire mesh reinforced concrete
Electric Installation (480V, 3P, 200A)	1	LS	$20,000	$20,000	Estimate
Sanitation Plumbing	1	LS	$10,000	$10,000	Estimate

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TABLE B-1 Alternative 2 — **COST ESTIMATE SUMMARY**

CONSTRUCTION AND OPERATION OF ONSITE BIOCELL

Site:	Diamond Head Oil Superfund Site	**Description:**	Alternative 2 consists of excavation of contaminated soil, construction of an onsite biocell, onsite backfilling of amended soil, and operation & monitoring of the constructed biocell. Excavated soil from the two areas where LNAPL is found in monitoring wells will be disposed of at an off-site TSDF. The project duration is anticipated to be 6 years. Capital costs occur in Year 0-1. Annual O&M costs occur in Years 1-6. Periodic costs occur in Year 6.
Location:	Kearny, New Jersey		
Phase:	Feasibility Study (-30% to +50%)		
Base Year:	2009		
Date:	June 4, 2009		

Process Plumbing	1	LS	$25,000	$25,000	Vendor quote from Maple Leaf Environmental.
Air Delivery Blower System	1	LS	$60,400	$60,400	Vendor quote from Maple Leaf Environmental. Purchased.
Air Delivery Piping, 2" SCH 40 PVC	1,850	LF	$50	$92,500	Piping from treatment building to the start of the perforated piping. 200 ft per cell for delivery; 670 ft of delivery pipe to southern RTA; 180ft to northern RTA.
Nutrient Delivery Piping, 2" SCH 40 PVC	1,850	LF	$50	$92,500	Same as above.
Nutrient Delivery Equipment	1	LS	$6,600	$6,600	500 gallon polypropylene chemical (fertilizer) tank with transfer pump (10 gpm, 40 psi). Purchased
Equipment Repair and Parts Allowance	1	LS	$10,000	$10,000	
Control System w/ Switching Manifold	1	LS	$8,000	$8,000	PLC based control system with telemetry, programmed.
Misc Valves and Fittings	1	LS	$5,000	$37,000	Estimate
SUBTOTAL				$437,488	
10 Soil Backfill and Compaction					
Backfill Amended Soil into Cells	70,800	CY	$15	$566,400	Includes cost of mixing amended soil with excavator.
Surface Grading	19,640	SY	$2.00	$39,280	Surface grading to achieve appropriate drainage.
Re-place Excavated Berm	8,900	CY	$7.00	$62,300	Assumes soil reuse, no imported soil
SUBTOTAL				$667,980	
11 Wastewater Disposal					
Transportation / Recycle LNAPL	59,500	GAL	$0.60	$35,700	Vendor quote from Lewis Environmental.
PVSC Fee During Construction	1	LS	$16,131	$16,131	See assumptions
KMUA Fee During Construction	1	LS	$96,058	$96,058	See assumptions
Quarterly Analytical Sampling of Discharge Water	4	EA	$2,016.00	$8,064	Assumes analysis through CLP, assumes quarterly sampling requires 1 day for 2 people.
Quarterly Report Preparation	4	EA	$2,016.00	$8,064	Assumes that it will require 24 hours to prepare.
SUBTOTAL				$164,017	
12 Groundwater Monitoring Well Installation					
Groundwater Wells	12	EA	$3,000.00	$36,000	See assumptions
Waste Disposal	1	LS	$10,000	$10,000	
SUBTOTAL				$46,000	
SUBTOTAL				$11,385,250	
Contingency	25%			$2,846,312	Scope and bid contingency
SUBTOTAL				$14,231,562	
Health and Safety	2%			$284,631	
Project Management	5%			$711,578	
Construction Management	6%			$853,894	
Total Capital Costs				$16,081,665	
Operation and Maintenance Costs					
14 Biocell Operation					
Addition of Nutrients	103,815	Gal	$2.50	$259,538	Assumes 20 full nutrient doses (4 times per year of operation). See assumptions
Equipment Repair and Parts	1	LS	$10,000	$10,000	Rental of monitoring equipment.
Utilities	60	MO	$2,000	$120,000	
Vegetation mowing	30	MO	$850	$25,500	Assumes 10 acres in need pf mowing will require 10 hours at $75/hour (labor and equipment) plus $100 to mobiliza or total $850/mowing.
Operations and Maintenance Labor	60	MO	$8,064	$483,840	Assumes 2 people, 12 hrs/week operations staff.
Monthly Performance Field Screening Labor	60	MO	$2,016	$120,960	Assumes 2 people, one 12 hr day/month.
Annual Analytical Soil Gas Samples	30	EA	$250	$7,500	Assumes 1 sample from each of the 6 cells for 5 years, assumes sampling can be combined with routine O&M activities.
Annual Geoprobe Soil Sampling	5	EA	$2,000	$10,000	Assumes one day of geoprobe per sampling event, assumes sampling can be combined with routine O&M activities.
Annual Analytical Soil Samples	30	EA	$120	$3,600	6 Samples (1 from each cell) per year for analysis of SPLP extract for oil and grease. Assumes same cost for SPLP VOC analysis.
SUBTOTAL				$1,040,938	
15 Wastewater Treatment (for dewatering water)					
Quarterly Analytical Sampling of Discharge Water	20	EA	$2,016.00	$40,320	Assumes CLP, assumes quarterly sampling throughout operation.
Quarterly Report Preparation	20	EA	$2,016.00	$40,320	Assumes that it will require 24 hours to prepare.
PVSC Discharge Fee	1	LS	$46,276.000	$46,276	
KMUA Discharge Fee	1	LS	$278,417.00	$278,417	
Utilities	60	MO	$2,000	$120,000	
SUBTOTAL				$525,333	
16 Verification Sampling					
Groundwater Sampling	3	EVENT	$8,064	$24,192	Assumes CLP analysis.
Geoprobe Soil Sampling	3	EA	$2,000	$6,000	Assumes one day of geoprobe per sampling event, assumes sampling can be combined with routine O&M activities.
Analytical Soil Samples	18	EA	$120	$2,160	Assumes 6 samples per event for analysis of SPLP extract for oil and grease. Assumes same cost as for SPLP VOC analysis.
Waste Disposal	1	LS	$10,000	$10,000	
SUBTOTAL				$42,352	

TABLE B-1 Alternative 2			COST ESTIMATE SUMMARY
CONSTRUCTION AND OPERATION OF ONSITE BIOCELL			
Site:	Diamond Head Oil Superfund Site	**Description:**	Alternative 2 consists of excavation of contaminated soil, construction of an onsite biocell, onsite backfilling of amended soil, and operation & monitoring of the constructed biocell. Excavated soil from the two areas where LNAPL is found in monitoring wells will be disposed of at an off-site TSDF. The project duration is anticipated to be 6 years. Capital costs occur in Year 0-1. Annual O&M costs occur in Years 1-6. Periodic costs occur in Year 6.
Location:	Kearny, New Jersey		
Phase:	Feasibility Study (-30% to +50%)		
Base Year:	2009		
Date:	June 4, 2009		

17 Closure					
Sheet Pile Removal	129,500	SF	$4	$518,000	Vendor quote from Ratto Construction.
Sheet Pile Salvage	129,500	SF	-$11	-$1,424,500	Vendor quote from Ratto Construction. (Vendor credit)
SUBTOTAL				-$906,500	
SUBTOTAL				$702,123	
Contingency	25%			$175,531	Scope and bid contingency
SUBTOTAL				$877,653	
Health and Safety	2%			$17,553	
Project Management	6%			$52,659	
Technical Support	10%			$87,765	
Total 5 Year Operating O&M Costs				$1,035,631	

Periodic Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Remedial Action Report	1	1	EA	$15,000	$15,000	
SUBTOTAL					$15,000	
Contingency		25%			$3,750	
SUBTOTAL					$18,750	
Project Management		6%			$1,125	
Total Periodic Costs					$19,875	

Present Value Analysis

Cost Type	YEAR		TOTAL COST	NOTES
Capital Cost	0		$16,081,665	
Annual O&M Cost	1-6		$1,237,312	
Periodic Cost	6		$19,875	
TOTAL PRESENT VALUE OF ALTERNATIVE		**DISCOUNT FACTOR (2.7%)***	$17,338,852	*Discount Factor based on OMB App C 30-year for 2009

Assumptions:

1 Pre-Design Investigation

Assumes that the cost will be similar to the Phase 2 RI costs.

3 Pre-Remediation Site Work

Vegetation will be cleared east and north of the landfill to accommodate site operations, locating facilities, and constructing temporary access roads.

Sewer connection to KMUA/PVSC sewer is based on the distance from the intersection of Harrison and Bergen Ave to the proposed onsite waste water treatment facility location. Assumes that KMUA will have completed the construction of their sewer line to which the sewer from Diamond Head will connect before the start of remedial activities. Assumes a 4 ft deep trench with pipe bedding material imported. Estimated length of piping is 750 ft, 8 in diameter.

Assumes a water connection to the 24 in water main running along the southern side of Harrison Ave. Estimated length of piping is 400 ft, 2 in diameter.

Assumes the northwest section of the site will require a gravel layer to support onsite equipment and vehicles. Assumes a new temporary road and turn around area will be required to allow access to all cells (see site plain view figures).

4 LNAPL Impacted Soil Excavation

The sheet pile wall for the two areas where LNAPL is found in monitoring wells is estimated to be approximately 600 ft by 35 ft deep. Assumes AZ36 Sheet Pile and A572 Grade 50 Steel will be used. Cost is for single use around these areas.

5 Building Foundation Excavation

Assumes existing building foundation is 100 ft x 50 ft x 2 ft. Also assumes that brick and concrete rubble located in the 0-0.5 ft bgs interval throughout triangle RTA area will be removed.

Assumes excavations and stockpiling can be completed at a rate of 1,000 CY per day.

6 Onsite Soil Berm Excavation

Assumes area of berm requiring removal is 24,000 SF with a height of 10 ft.

7 Dewatering

Pumps are assumed to dewater excavation at the rate of 200 gpm.

8 Wastewater Treatment

Includes the cost of purchase of the treatment system. Costs are based on vendor quote for Mapple Leaf Environmental.

9 Construction of Bioremediation Cells

Sheet pile wall covers perimeter of RTA and includes four partitions for a total length of 3,700 ft. Depth estmated at 35 ft. RTA divided into approximately 30,000 SF cells as shown in the plan view figure. Assumes AZ36 Sheet Pile and A572 Grade 50 Steel will be used. Vendor quote from Ratto Construction are for leaving the sheet pile wall in place for 5 years. Quote accounts for pulling of the sheet pile and salvage value.

Air and nutrient perforated piping - 940 ft in cell, 1, 900 ft in cell 2, 808 ft in cell 3, 1,040 ft in cell 4, 880 ft in cell 5, 744 ft in cell 6.

10 Bioremediation Delivery From Treatment Building to Cells

LNAPL quantity assumes 2% LNAPL in water from initial dewatering of the RTA (3.418 million gallons).

12 and 15 Wastewater Disposal

TABLE B-1 Alternative 2			COST ESTIMATE SUMMARY
CONSTRUCTION AND OPERATION OF ONSITE BIOCELL			
Site:	Diamond Head Oil Superfund Site	**Description:**	Alternative 2 consists of excavation of contaminated soil, construction of an onsite biocell, onsite backfilling of amended soil, and operation & monitoring of the constructed biocell. Excavated soil from the two areas where LNAPL is found in monitoring wells will be disposed of at an off-site TSDF. The project duration is anticipated to be 6 years. Capital costs occur in Year 0-1. Annual O&M costs occur in Years 1-6. Periodic costs occur in Year 6.
Location:	Kearny, New Jersey		
Phase:	Feasibility Study (-30% to +50%)		
Base Year:	2009		
Date:	June 4, 2009		

Refer to Table in Appendix A for basis for LS.

13 Groundwater Monitoring Well Installation

2" wells, 2 wells in the northern area, 10 wells in the southern area

14 Biocell Operation

Assumes the addition by volume of the following nutrients: 0.015% N, 0.001% P, and 0.0005% K. Assumes four dosages per year.

Note: Estimated costs do not include decommissioning of constructed biocell.

400181

Appendix C

APPENDIX C

Conceptual Design Alternative 3 – Excavation, Onsite Treatment via Soil Washing, and Onsite Backfilling of Treated Soil

Alternative Description

Alternative 3 relies on the soil washing technology to achieve the PRGs within the RTA. The alternative consists of the excavation of the soil within the RTA, onsite treatment through soil washing, onsite beneficial reuse of the cleaned coarse soil fractions (i.e., >74 µm) as general backfill material, and treatment or disposal of LNAPL and the enriched fines fractions (<74 µm) generated during the soil washing process.

Ex situ soil separation processes (often referred to as "soil washing") are mostly based on mineral processing techniques, and are widely used in Northern Europe and America for the treatment of contaminated soil. Soil washing is a water-based process for scrubbing soil ex situ to remove contaminants. The process removes contaminants from soil in one of the following two ways:

- By dissolving or suspending them in the wash solution (which can be sustained by chemical manipulation of pH for a period of time); or
- By concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing (similar to those techniques used in sand and gravel operations).

The concept of reducing soil contamination through the use of particle size separation is based on the finding that most organic and inorganic contaminants tend to bind, either chemically or physically, to clay, silt, and organic soil particles. The silt and clay, in turn, are attached to sand and gravel particles by physical processes, primarily compaction and adhesion. Washing processes that separate the fine (small) clay and silt particles from the coarser sand and gravel soil particles effectively separate and concentrate the contaminants into a smaller volume of soil. Gravity separation is effective for removing high or low specific gravity particles such as heavy metal-containing compounds (lead, radium oxide, etc.). Attrition scrubbing removes adherent contaminant films from coarser particles, however, attrition washing can increase the fines in processed soil. Each process generates enriched contaminated fines that can be further treated or disposed. For the purposes of this FS, it is assumed that fines generated during soil washing would be disposed offsite. The clean, larger fraction would be returned to the site as backfill.

The target contaminant groups for soil washing are typically SVOCs, fuels, and heavy metals, however, the technology can also be used on selected VOCs and pesticides. For the Diamond Head Superfund Site, soil washing would be targeted specifically at free phase NAPL and dissolved petroleum compounds. However, modifications to the washing process may be implemented to treat other COPCs present at the site if this additional treatment was determined to be desirable. Complex mixtures of contaminants in the soil (such as a mixture of metals, nonvolatile organics, and SVOCs) and heterogeneous contaminant compositions throughout the soil mixture make it a challenge to formulate a single suitable washing solution that will consistently and reliably remove all of the different types of contaminants. Sequential washing, using different wash formulations and/or different soil to wash fluid ratios, may be required for these instances.

Factors that may limit the applicability and effectiveness of the soil washing process include:

- Complex waste mixtures (e.g., metals with organics) make formulating washing fluid difficult.
- High humic content in soil may require pretreatment.
- The aqueous stream will require treatment at demobilization.
- Additional treatment steps may be required to address hazardous levels of washing solvent remaining in the treated residuals.
- It may be difficult to remove organics adsorbed onto clay-size particles.
- Preparing a homogenized soil feed to the process is important.

The soil washing technology is contaminant specific and vendor-specific. For the Diamond Head Superfund Site, treatability testing on representative site soil samples will be needed to determine the specific soil washing unit processes that would be effective in treating the soil to the established PRGs. Based on this treatability testing, the determination will also be made during remedial design whether to excavate and dispose offsite of the soil within the two areas within the RTA where LNAPL product is found in wells or whether this soil can also be treated onsite via soil washing. For the purposes of this FS, it is assumed that the soil from these two areas would be stabilized and disposed offsite. For the process design, it will be important to have information on the type /size of debris within the soil and the soil particle size distribution; this will require some test pitting and sampling within the RTA during the design phase of the project.

Implementation of soil washing technology at the Site would include the following general steps (more details are provided below);

- Confirming the RTA and dividing the RTA into treatment cells using low permeability sheet pile (e.g. Waterloo Barrier with sealed joints) to isolate the cells, support the excavation side walls and minimize the infiltration of groundwater during the excavation.. Sheet pile installation would proceed one cell at a time with the sheet pile wall removed from the perimeter of a cell where treatment is completed and placed around the perimeter of the next cell to the excavated and treated.
- Excavate the cell to be treated. The excavation would be dewatered prior to and during the excavation, and the water treated before discharge through a sewer connection (constructed as part of the alternative) to a public sewer leading to the PVSC treatment plant. Based on review of the Phase 1 groundwater data relative to PVSC discharge requirements, oil-water separation and settlement for TSS are the treatment processes included before discharge of the water.
- Pre-process excavated soil (for example, screen to remove large debris greater than six inches diameter), stockpile, and process through the soil washing unit (designed based on treatability test results). This may include wash additive agents, such as surfactants, co-solvents, and/or acidic/basic solutions could be used to cleanse soil and desorb, dissolve and mobilize the contaminants, including residual LNAPL for subsequent removal and treatment either within the washwater phase or the enriched fines fractions (generally <74 μm).

- Following the treatment, stockpiled soil would be sampled to assess whether the soil following backfilling would meet the PRGs (technology performance sampling). If the desired treatment has been achieved, the soil would be placed back in the cell and compacted as a general fill material. Clean soil fill would be imported and mixed with the washed soil to fill the cells back to grade. Clean fill would replace the volume which was reduced as a result of the removal of the concrete debris and separation of enriched fines (assumed to be disposed of offsite).
- Soil that has not achieved the desired level of treatment would be re-washed, and modifications may be made to the washing process to increase the effectiveness of the wash additive agents.
- Two monitoring wells would be installed in each cell following its completion and sampled to confirm that the PRGs were met in treated soil at the end of the alternative.

Soil washing is generally considered a media transfer technology. The contaminated water generated from soil washing is treated with the technology(s) suitable for the contaminants. The waste streams expected from this alternative include:

- Water from dewatering activities to be discharged through a public sewer to PVSC
- Concrete foundations and other large debris within the RTA to be recycled or disposed at offsite disposal facility
- Soil from the two areas where LNAPL was observed in monitoring wells (assumed to require stabilization and offsite disposal)
- LNAPL separated from the water from dewatering activities and LNAPL separated from the soil washing liquid to be recycled or disposed at an offsite disposal facility
- Washing liquid from the soil washing process to be discharged to PVSC following onsite treatment by the soil washing vendor
- Filter cake / enriched fines remaining after treatment (assumed to be disposed at an offsite disposal facility)

The duration of construction of this alternative is anticipated to be approximately 1 year following which the PRGs established in this FFS are expected to be achieved (no measureable LNAPL thickness in monitoring wells). The construction duration and estimated costs assume that cells will be excavated, treated, and backfilled sequentially. The actual duration may be shorter since some activities can be scheduled to proceed in parallel. The estimated duration is based on the following:

Activity	Weeks
Initial Dewatering	2
Excavation	10
Loadout	1
Backfill	10
Soil Washing	31
Total	54

The soil washing process and costs included under Alternative 3 in this FFS were developed to address the treatment of the soil within the RTA for LNAPL to the established PRGs. Commercial vendors have indicated that the soil washing process can also be designed to treat the soil for other COPCs with the treated soil, potentially meeting the New Jersey Nonresidential Soil Cleanup Standards. Treatability testing would be needed to develop the soil washing process for either just treating for the LNAPL or for treating both the LNAPL as well as other COPCs. While the costs for treating both LNAPL and other COPCs cannot be estimated without treatability testing, it would be reasonable to assume that they would be higher than the costs estimated in this FFS for only treating for the LNAPL.

Conceptual Design

Figure C-1 shows the RTA, the conceptual layout of the cells in which the excavation would proceed, and the areas where soil washing equipment would be situated at the site. Figure C-2 is a cross section showing the conceptual excavation.

Based on the information provided by vendors, the soil washing modular system will likely consist of multiple processes, including debris screening, rotary trammel screening, soil washing scrubbing unit, filter press dewatering, vibratory screen dewatering, and wastewater treatment plant. A conceptual soil washing process flowchart is shown in Figure C-3.

The design basis for Alternative 3 developed for this FFS is provided below.

Pre-design Investigation

- Conduct a pre-design investigation to:
  - Define the RTA boundaries.
  - Characterize soil and concrete foundations / debris for disposal purposes.
  - Characterize the soil berm to determine if the existing soil can be re-used to replace the removed berm at the end of remedial activities.

For cost estimating purposes, the investigation is assumed to be of similar scope and cost as the Phase 2 RI.

Remedial Design

- Complete the full-scale system design and procure subcontractors for its installation; coordinate with various entities (e.g., POTW PVSC and NJDEP)
- Perform treatability bench/pilot scale testing to determine most appropriate soil washing process.

Pre-Remediation Site Work

- Clear vegetation east and north of the landfill to accommodate operations, locating facilities, and constructing temporary access roads. Estimated area of 480,000 SF.
- Construct sewer connection from the proposed onsite wastewater treatment facility to the KMUA/PVSC sewer system located at the intersection of Harrison and Bergen Ave. Sewer size 750 ft length of 8 inch diameter pipe.
- Create an onsite water source by connecting to the 24 inch water main located on the southern side of Harrison Ave. Pipe size 400 ft length of 2 inch diameter pipe.
- Construct temporary access roads, turnaround area, and a lay-down area (assumed 6 inches of gravel) to support onsite construction vehicles and remedial facilities. Estimated area of 67,100 SF.

Soil Excavation

- Install isolation sheet pile system around the first cell of the RTA that will be treated. Sheet pile installation and excavation/treatment would progress from cell to cell, with the sheet pile from the first cell re-used for subsequent cells. Total length of sheet pile covers the perimeter of the largest cell, and the perimeter of the two areas where LNAPL is found in monitoring wells (1,000 ft and 600 ft, respectively).

- Excavate and stockpile 24,000 SF of the approximately 10 ft high soil berm, and stage onsite in stockpiles. Estimated volume approximately 8,900 CY.
- Excavate concrete foundations within RTA - assumed concrete foundations cover a total of approximately 100 ft by 50 ft with an assumed thickness of 24 inches. In addition, we have assumed 500 CY of miscellaneous concrete debris in the northern triangular RTA. Concrete and debris will be transported for offsite disposal/recycling. Estimated volume 900 CY.
- Excavate soil within areas containing measureable LNAPL thickness in wells – estimated 10,000 SF to average depth of 7 ft bgs. LNAPL impacted soil will undergo onsite stabilization in preparation for offsite transportation and disposal. Estimated volume 2,600 CY.
- Excavate and stockpile soil within remainder of RTA - 166,800 SF to average depth of 7 ft bgs. Estimated volume 42,400 CY.
- Excavation is assumed to proceed sequentially in each cell, approximately 30,000 SF each.

Dewatering

- Dewater each treatment cell prior to and during excavation and treat as described below. Dewatering of the RTA is estimated to require approximately 2 weeks (assume 200 gpm dewatering rate).
- Initial water volume from dewatering RTA is estimated at 2,972,900 gallons.
- Water volume from leakage through sheet pile wall and native clay layer during construction for entire RTA is estimated at 171,300 gal and water volume from rainwater is estimated at 444,000 gal.
- Total water volume is estimated at 3,588,200 gallons during construction.

Treatment and Disposal of Water from Dewatering

- Treat water from dewatering of excavations using modular treatment system during entire period of excavation.
- The modular treatment system would consist of:
  - Oil / water separator - size for effective oil and grease removal at a design flow of 200 gallons per minute for water and 10 gallons per minute for LNAPL.
  - Settlement tank(s) - size for effective TSS settlement to provide appropriate residence time in relation to the maximum flow rate and meet typical PVSC TSS criteria (250ml/L) is estimated to be two 5,000 gallon polypropylene tanks.
- Discharge treated effluent to KMUA/PVSC via sewer connection.
- Sample treated effluent to monitor compliance with PVSC requirements.

Soil Washing

- Mobilize soil washing units, estimated to have maximum capacity to treat 45 tons per hour (TPH); average operating capacity assumed to be 20 TPH. Soil washing activities assumed to take place for 20 hours per day for 6 days per week.
- Stage soil following soil washing and sample to confirm PRGs were met.
  - Return soil that does not meet PRGs for additional soil washing.
  - Backfill soil that meet PRGs.
- Treat excess liquids from soil washing using modular treatment system (note that this is a separate system from the system used to treat the water from dewatering).
- Characterize filter cake, assumed to be 15% of the processed soil, or 7,000 CY, assumed to be hazardous waste, disposed of at subtitle C RCRA facility.

Soil Backfill and Compaction

- Import clean soil to offset the waste streams that reduced the volume of soil within the RTA - soil from the two areas where LNAPL was found in wells, the filter cake, and the concrete – estimated at 9,900 CY.
- Backfill and compact.
- Following backfilling, install 2 groundwater monitoring wells in each cell.
- Re-place excavated berm with the same soil to pre-remedial dimensions (assumed that following supplemental pre-design investigation, the material is found to be of acceptable characteristics).
- Pull the sheet piles and remove from the site.

Transportation and Offsite Disposal of Other Wastes

- Transport for offsite disposal/recycling concrete foundations and building debris – estimated concrete volume is 900 CY, assumed non hazardous.
- Transport for offsite disposal approximately 2,600 CY of soil excavated from 2 areas where measurable product thickness is observed in wells, assumed non hazardous. Treat soil via stabilization before sending for offsite disposal.
- Transport for offsite disposal/recycling 59,500 gal of LNAPL separated from water during dewatering, assumed non hazardous.
- Dispose of/recycle above waste streams in RCRA-permitted facilities (subtitle D).
- Transport and dispose of filter cake – estimated at 6,400 CY at Subtitle C RCRA facility. Treat filter cake with stabilization if needed.
- Discharge to PVSC of the treated blowdown from the soil washing estimated at 120,000 gal (assuming 15,000 gal per month for 8 months of operation).
- Assume no LNAPL separated from the soil washing liquid, LNAPL assumed to be bound to filter cake.

Verification Sampling

- Discontinue dewatering sump operation and allow the cells to flood via surface water infiltration (may take several months).
- Sample soil and groundwater from monitoring wells, monitor for the presence of LNAPL and analyze samples for selected parameters. Assume 3 events to confirm.

Closure

- Pull the sheet piles and remove from the site.

Operation and Maintenance

- None; no 5-year reviews.

Of note, air emissions from the excavation activities were estimated in order to evaluate the various regulatory requirements that may affect alternative implementation. The analytical soil results collected during the Phase 1 investigation were used to estimate an average concentration for detected VOCs. The average concentration was calculated based on detected VOC concentrations within the vertical and horizontal limits of the RTA. The partitioning calculations performed using these average concentrations suggest that VOC emissions during excavation activities would be below the NJDEP reporting thresholds with the exception of the emissions of 1,1-Dichloroethylene and vinyl chloride. The partitioning calculations suggest that all VOC emissions would be below the NJDEP SOTO levels and as such may not require emissions controls but will require monitoring. This will be verified during the remedial design when the emissions will be estimated for the final RTA footprint and the request for determination or a permit application (as applicable) would be prepared and submitted to the NJDEP. This FFS assumes that emissions controls would not be required (including for emissions from combustion equipment operated at the site).

Estimated Costs

The capital present worth cost for Alternative 3 is identified in the table below. The detailed cost elements are provided in Table C-1. Note that this alternative would not have operations and maintenance and periodic costs.

	Estimated Present Worth Cost	Occurs in Year
Capital Cost	$18,557,073	Year 0
O&M Cost	$0	--
Periodic Cost	$0	--
Total Cost	$18,557,073	

References:

USEPA Webstie: http://clu-in.org/techfocus/default.focus/sec/Soil_Washing/cat/Overview/%22

Information on soil washing process and costs were obtained from the following vendors of the technology:

ART Engineering, LLC
12526 Leatherleaf Drive
Tampa, FL 33626 USA

BioGenesis Enterprises, Inc.
7420 Alban Station Blvd. Suite B-208
Springfield, Virginia 22150

Boskalis Dolman bv
3350 AA Papendrecht
Rotterdam, The Netherlands

DEC UK Ltd
2nd Floor Greenstede House
Wood Street, East Grinstead
West Sussex, RH19 1UZ
Great Britain

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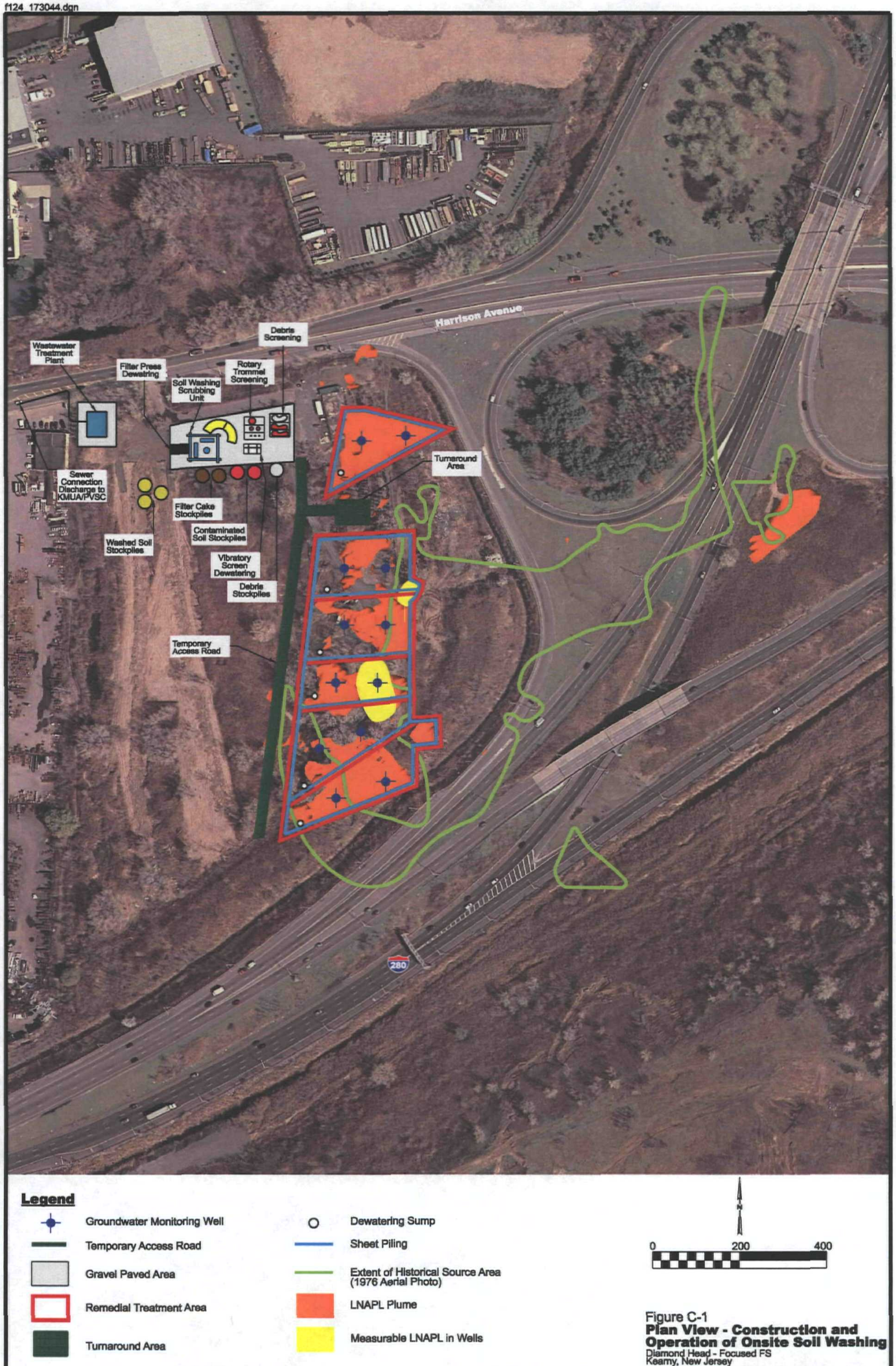

Figure C-1
Plan View - Construction and Operation of Onsite Soil Washing
Diamond Head - Focused FS
Kearny, New Jersey

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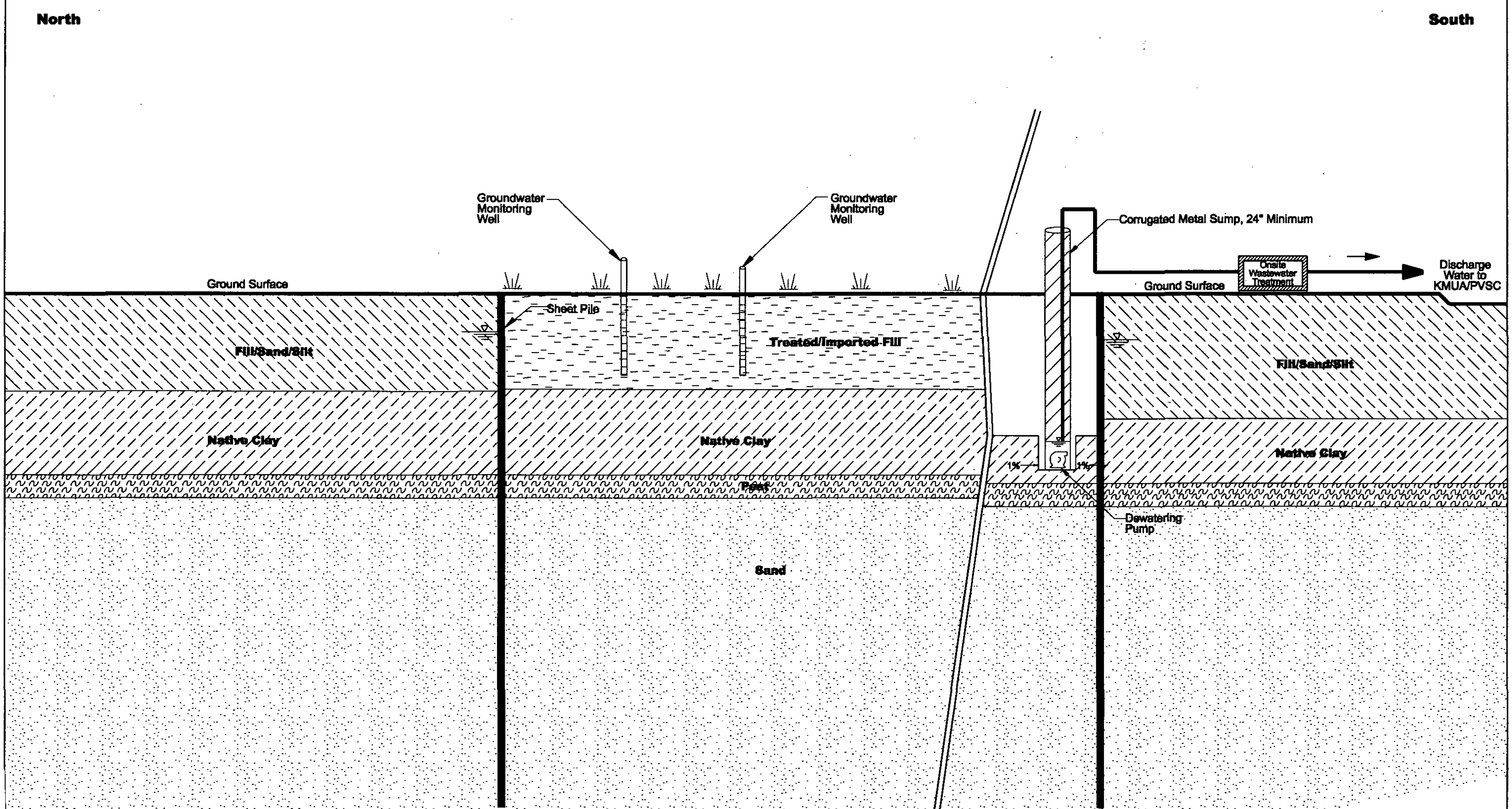

Figure C-2
Soil Washing and Excavation Conceptual Cross Section
Diamond Head - Focused FS
Kearny, New Jersey

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Figure C-3

Conceptual Soil Washing Process Flowchart

Diamond Head Oil Superfund Site, Kearny New Jersey

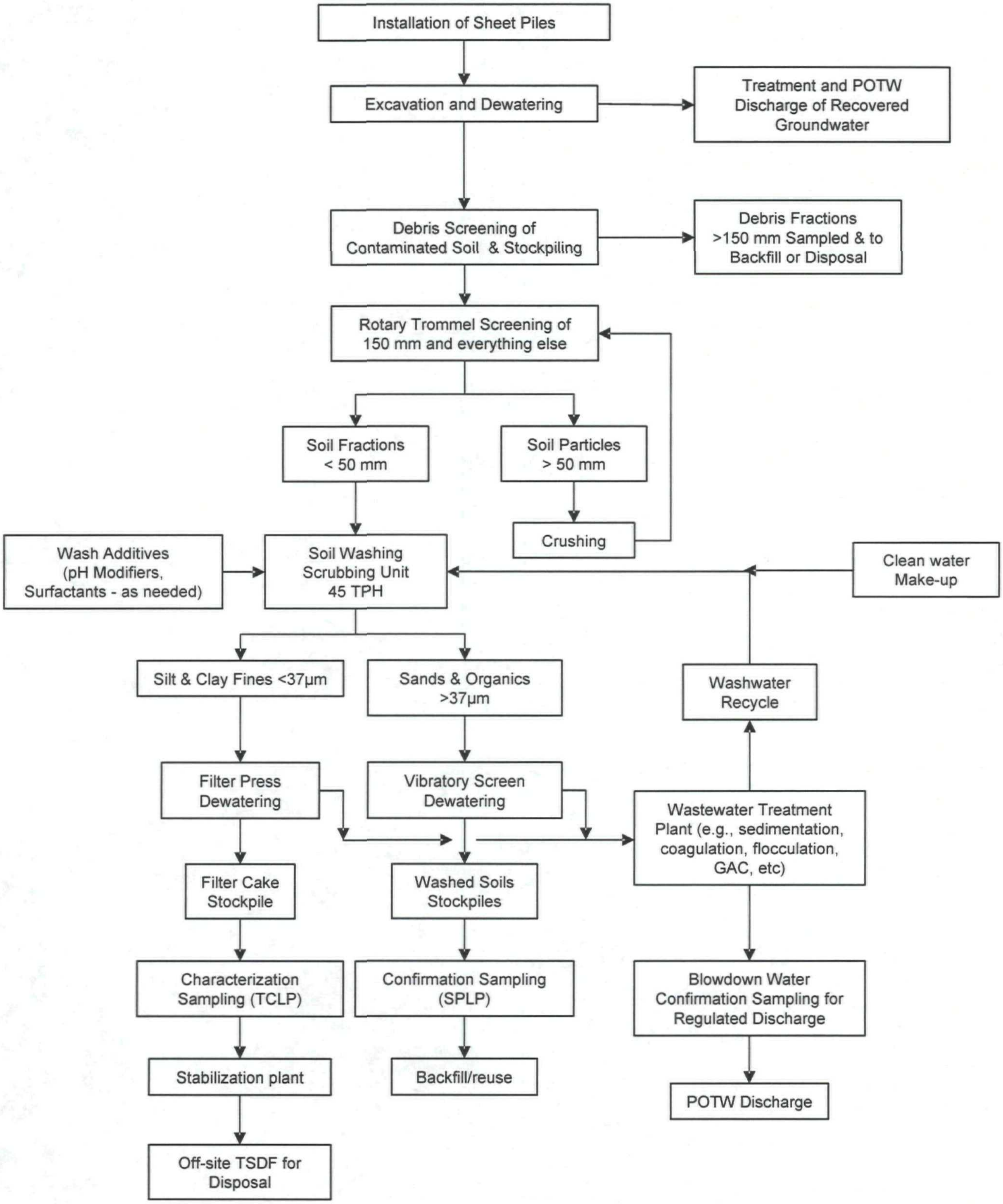

TABLE C-1 Alternative 3

COST ESTIMATE SUMMARY

EXCAVATION, ONSITE TREATMENT VIA SOIL WASHING, AND ONSITE BACKFILLING OF TREATED SOILS

Site: Diamond Head Oil Superfund Site
Location: Kearny, New Jersey
Phase: Feasibility Study (-30% to +50%)
Base Year: 2009
Date: June 4, 2009

Description: Alternative 3 consists of excavation, onsite soil washing, and onsite backfilling of treated soil. Excavated soil from the two areas where LNAPL is found in monitoring wells will be disposed of at an off-site TSDF. The project duration is anticipated to be 1 year. Capital costs occur in Year 0.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
1 Mobilization/Demobilization					
Construction Equipment & Facilities	1	LS	$80,000	$80,000	
Submittals/Implementation Plans	1	LS	$15,000	$15,000	Work plan, health and safety plan, permits, etc.
Temporary Facilities	12	MO	$1,000	$12,000	Office trailers, storage facilities, sanitary facilities.
Post-Construction Submittals	1	LS	$15,000	$15,000	
SUBTOTAL				$122,000	
2 Pre-Remediation Site Work					
Clearing and Grubbing	11	AC	$3,000	$33,000	See assumptions
Fencing/Signs/Gates	440	LF	$20	$8,800	Assumes 10% of the perimeter of the site will require new fencing, signs, and gates.
Construction of Sewer Connection	750	LF	$95	$71,250	See assumptions
Construction of Water Connection	400	LF	$65	$26,000	See assumptions
Construction of Temporary Electric Service	1	LS	$25,000	$25,000	Estimate
Construction of Temporary Roads and Gravel Lay Down	67,110	SF	$0.90	$60,399	6 in thick gravel, see assumptions.
SUBTOTAL				$224,449	
3 LNAPL Impacted Soil Excavation					
Sheet Pile Installation	21,000	SF	$44	$924,000	For 2 impacted areas, approximate 600 ft by 35 ft deep. Vendor quote from Ratto Construction.
Excavation and Hauling	2,600	CY	$15	$39,000	
Transportation and Disposal	4,160	TON	$82	$339,456	Vendor quote from Lewis Environmental. Cost includes price of stabilization.
Characterization sampling	3	EA	$600	$1,800	Vendor quote indicates 1 sample per 1,600 tons.
LNAPL Sheet pile Removal	21,000	SF	$4	$84,000	Vendor quote from Ratto Construction.
SUBTOTAL				$1,388,256	
4 Building Foundation Excavation					
Concrete Foundation Demolition	400	CY	$65	$26,000	
Concrete Foundation and Rubble Excavation and Hauling	900	CY	$25	$22,500	See assumptions.
Transportation / Recycle Material	1,440	TON	$16	$23,040	Vendor quote from Lewis Environmental.
SUBTOTAL				$71,540	
5 Onsite Soil Berm Excavation					
Excavation and Hauling	8,900	CY	$12	$106,800	See Assumptions.
Stockpiling	8,900	CY	$5	$44,500	
SUBTOTAL				$151,300	
6 Dewatering					
Dewatering /Leachate Sump Pumps	12	MO	$2,040	$24,480	Rental of six sump pumps operating at 50 gpm
2" HDPE Trenching and Piping	1,000	LF	$18	$18,000	1000' of leachate piping. Includes cost for trenching of pipe.
SUBTOTAL				$42,480	
7 Wastewater Treatment (for dewatering water)					
Rental of Treatment System	12	MO	$4,900	$58,800	Vendor quote from Maple Leaf Environmental. Includes mobilization costs.
Equipment Repair and Parts	1	LS	$10,000	$10,000	
SUBTOTAL				$68,800	
8 Soil Washing					
Sheet Pile Installation, Removal, and Reuse	35,000	SF	$76	$2,660,000	See assumptions
Excavation and Hauling of RTA Soil	42,400	CY	$15	$636,000	Assumes RTA volume minus LNAPL impacted soils, building foundation, and concrete rubble and to a depth of 7 ft bgs.
Stockpile RTA Soil	42,400	CY	$5	$212,000	
Soil Washing Process	67,900	TON	$70	$4,753,000	Vendor quotes depending on items included range from $32 to $70/ton.
Characterization sampling of Filter Cake	6	EA	$600	$3,600	Vendor quote indicates 1 composite sample per 1,600 tons.
Transportation, Treatment, Disposal for Filter Cake	10,200	TON	$190	$1,938,000	Based on vendor quote received from Lewis Environmental. Includes stabilization. Assumes filter cake is hazardous.
SUBTOTAL				$10,202,600	
9 Soil Backfill and Compaction					
Import Clean Soil	9,900	CY	$15	$148,500	General fill, see assumptions
Surface Grading	19,640	SY	$2	$39,280	Surface grading to achieve appropriate drainage.
Backfilling and Compaction	45,900	CY	$7	$321,300	See Assumptions
Re-place Excavated Berm	8,900	CY	$7	$62,300	Assumes soil reuse, no import
Soil Verification Sampling	200	Samples	$120	$24,000	Assumes 1 sample per every 400 CY for analysis of SPLP extract for oil and grease.
SUBTOTAL				$595,380	
10 Wastewater Disposal					
Transportation / Recycle LNAPL	59,500	GAL	$0.60	$35,700	Vendor quote from Lewis Environmental.
PVSC Fee During Construction	1	LS	$16,495	$16,495	See assumptions
KMUA Fee During Construction	1	LS	$99,271	$99,271	See assumptions

400193

TABLE C-1 Alternative 3 | **COST ESTIMATE SUMMARY**

EXCAVATION, ONSITE TREATMENT VIA SOIL WASHING, AND ONSITE BACKFILLING OF TREATED SOILS

Site: Diamond Head Oil Superfund Site
Location: Kearny, New Jersey
Phase: Feasibility Study (-30% to +50%)
Base Year: 2009
Date: June 4, 2009

Description: Alternative 3 consists of excavation, onsite soil washing, and onsite backfilling of treated soil. Excavated soil from the two areas where LNAPL is found in monitoring wells will be disposed of at an off-site TSDF. The project duration is anticipated to be 1 year. Capital costs occur in Year 0.

Quarterly Analytical Sampling of Discharge Water	4	EA	$2,016.00	$8,064	Assumes analysis through CLP, assumes quarterly sampling requires 1 day for 2 people.
Quarterly Report Preparation	4	EA	$2,016.00	$8,064	Assumes that it will require 24 hours to prepare.
SUBTOTAL				$167,594	
11 Groundwater Monitoring Well Installation					
Groundwater Wells	12	EA	$3,000.00	$36,000	See assumptions
Waste Disposal	1	LS	$10,000	$10,000	
SUBTOTAL				$46,000	
12 Verification Sampling					
Groundwater Sampling	3	EVENT	$8,064	$24,192	Assumes CLP analysis.
Geoprobe Soil Sampling	3	EA	$2,000	$6,000	Assumes one day of geoprobe per sampling event, assumes sampling can be combined with routine O&M activities.
Analytical Soil Samples	18	EA	$120	$2,160	Assumes 6 samples per event for analysis of SPLP extract for oil and grease. Assumes same cost as for SPLP VOC analysis.
Waste Disposal	1	LS	$10,000	$10,000	
SUBTOTAL				$42,352	
13 Remedial Action Report	1	EA	$15,000	$15,000	
SUBTOTAL				$15,000	
SUBTOTAL				$13,137,751	
Contingency	25%			$3,284,438	Scope and bid contingency
SUBTOTAL				$16,422,189	
Health and Safety	2%			$328,444	
Project Management	5%			$821,109	
Construction Management	6%			$985,331	
Total Capital Costs				$18,557,073	

Present Value Analysis

Cost Type	YEAR		TOTAL COST	NOTES
Capital Cost	0		$18,557,073	
Annual O&M Cost	0		$0	
Periodic Cost	0		$0	
TOTAL PRESENT VALUE OF ALTERNATIVE		**DISCOUNT FACTOR (2.7%)***	$18,557,073	*Discount Factor based on OMB App C 30-year for 2009

Assumptions:

1 Pre-Design Investigation
Assumes that the cost will be similar to the Phase 2 RI costs.

3 Pre-Remediation Site Work
Vegetation will be cleared east and north of the landfill to accommodate site operations, locating facilities, and constructing temporary access roads.
Sewer connection to KMUA/PVSC sewer is based on the distance from the intersection of Harrison and Bergen Ave to the proposed onsite waste water treatment facility location. Assumes that KMUA will have completed the construction of their sewer line to which the sewer from Diamond Head will connect before the start of remedial activities. Assumes a 4 ft deep trench with pipe bedding material imported. Estimated length of piping is 750 ft, 8 in diameter.

Assumes a water connection to the 24 in water main running along the southern side of Harrison Ave. Estimated length of piping is 400 ft, 2 in diameter.
Assumes the northwest section of the site will require a gravel layer to support onsite equipment and vehicles. Assumes a new temporary road and turn around area will be required to allow access to all cells (see site plain view figures).

4 LNAPL Impacted Soil Excavation
The sheet pile wall for the two areas where LNAPL is found in monitoring wells is estimated to be approximately 600 ft by 35 ft deep. Assumes AZ36 Sheet Pile and A572 Grade 50 Steel will be used. Cost is for single use around these areas.

5 Building Foundation Excavation
Assumes existing building foundation is 100 ft x 50 ft x 2 ft. Also assumes that brick and concrete rubble located in the 0-0.5 ft bgs interval throughout triangle RTA area will be removed.
Assumes excavations and stockpiling can be completed at a rate of 1,000 CY per day.

6 Onsite Soil Berm Excavation
Assumes area of berm requiring removal is 24,000 SF with a height of 10 ft.

7 Dewatering
Pumps are assumed to dewater excavation at the rate of 200 gpm.

8 Wastewater Treatment
Includes the cost of rental of the treatment system for a period of one year. Costs are based on vendor quote for Mapple Leaf Environmental.

9 Soil Washing
Sheet pile wall covers the perimeter of the largest cell estimated to be approximately 1000 ft. Depth estimated at 35 ft. Assumes AZ36 Sheet Pile and A572 Grade 50 Steel will be used. Vendor quote from Ratto Construction. Quote is for re-using the sheet pile wall from one cell to the next.
Soil Washing Treatment Process: Based on processing 20 tons per hour, for 20 hours per day, for 6 days per week.
Characterization sampling is based on collecting 1 sample per daily batch of treated soil.
Filter cake remaining after soil washing will be disposed of at an off-site disposal facility (assumed subtitle C). Assumed 15% of the soils cannot be treated by soil washing because particle size < 37 microns.

10 Soil Backfill and Compaction

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The volume of imported clean soil is based on the amount of soil required to replace the following:

a. volume of excavated soils in the two areas where LNAPL is found in monitoring wells that will be send for offsite disposal

b. volume of concrete foundations and debris removed for offsite disposal

c. volume of fines that cannot be treated and will remain as filter cake

11 Wastewater Disposal

Refer to Table in Appendix A for basis for LS.

Quanities for disposal include 15,000 gallons of blowdown from the soil washing system per month based on 8 months of system operation or a total of 120,000 gallons in addition to the quantities estimated to be dicharged under Alternative 2.

11 Groundwater Monitoring Well Installation

2" wells, 2 wells in the northern area, 10 wells in the southern area

Appendix D

APPENDIX D

Conceptual Design
Alternative 4 – Excavation and Offsite Disposal

Alternative Description

Alternative 4 consists of the excavation of soil within the RTA and its transportation for offsite disposal. The RTA would be divided into treatment cells and the excavation would proceed one cell at a time. Specifically, a sheet pile wall would be used to isolate a cell, support the excavation side walls, and minimize the infiltration of groundwater during the excavation. A rubber gasket would be used at the sheet pile joints to minimize infiltration. Prior to and during excavation of the soil within the cell, the cell would be dewatered and the water treated before discharge through a sewer connection (constructed as part of the alternative) to a public sewer leading to the PVSC treatment plant. Based on review of the Phase 1 groundwater data relative to PVSC discharge requirements, oil-water separation and settlement for TSS are the treatment processes included before discharge of the water.

The excavated soil would be stockpiled, loaded onto trucks, and transported for disposal at offsite disposal facilities. Clean fill would be imported to backfill the excavation to grade.

The implementation would proceed one cell at a time with the sheet pile wall left around the perimeter of each cell. At the end of the implementation period, the divider sheet pile walls would be removed, but the sheet pile wall around the RTA would remain to minimize the potential for recontamination of the soil. The sheet pile wall would be pulled up above the native clay layer, cut off below grade, and the surface grade finished such that a greater portion of the surface water infiltration would occur within the RTA versus the surrounding areas, thus maintaining a slight positive hydraulic gradient from within the RTA to the surrounding areas.

Two monitoring wells would be installed in each cell following its completion and sampled to confirm that the PRGs were met at the end of the alternative.

The waste streams expected from this alternative include:

- Water from dewatering activities to be discharged through a public sewer to PVSC
- LNAPL separated from the water from dewatering activities to be recycled or disposed at an offsite disposal facility
- Concrete foundations and other large debris within the RTA to be recycled or disposed at offsite disposal facility
- Soil from the RTA

The duration of construction of this alternative is anticipated to be approximately 8 months following which the PRGs established in this FFS are expected to be achieved. The construction duration and estimated costs assume that cells will be excavated and backfilled sequentially. The actual duration may be shorter as some activities can be scheduled to proceed in parallel, thus reducing the duration of implementation. The estimated duration is based on the following:

Activity	Weeks
Initial Dewatering	2
Excavation	10
Loadout	12
Backfill	10
Total	34

This alternative will result in the removal of all COPS from the RTA as the soil will be replaced with clean fill.

Conceptual Design

Figure D-1 shows the RTA and a conceptual layout of the cells in which the excavation would proceed.

The design basis for Alternative 4 developed for this FFS is provided below and summarized in Table 3-3.

Pre-design Investigation

- Conduct a pre-design investigation to:
  - Define the RTA boundaries.
  - Characterize soil and concrete foundations / debris for disposal purposes.
  - Characterize the soil berm to determine if the existing soil can be re-used to replace the removed berm at the end of remedial activities.

For cost estimating purposes, the investigation is assumed to be of similar scope and cost as the Phase 2 RI.

Remedial Design

- Complete design. Design components would include sheet pile design, dewatering and water treatment design, design of soil stockpiles, and excavation plan Procure various subcontractors; coordinate with various entities (e.g., POTW PVSC and NJDEP)

Pre-Remediation Site Work

- Clear vegetation east and north of the landfill to accommodate operations, locating facilities, and constructing temporary access roads. Estimated area of 480,000 SF.
- Construct sewer connection from the proposed onsite wastewater treatment facility to the KMUA/PVSC sewer system located at the intersection of Harrison and Bergen Ave. Sewer size 750 ft length of 8 inch diameter pipe.
- Create an onsite water source by connecting to the 24 inch water main located on the southern side of Harrison Ave. Pipe size 400 ft length of 2 inch diameter pipe.
- Construct temporary access roads, turnaround area, and a lay-down area (assumed 6 inches of gravel) to support onsite construction vehicles and remedial facilities. Estimated area of 67,100 SF.

Soil Excavation

- Install isolation sheet pile system around the entire RTA perimeter, and between each cell. Length of sheet piling is estimated at 3,700 ft to a depth of 35 ft bgs. This includes a sheet pile wall around the perimeter of the RTA and dividers between the cells.
- Excavate and stockpile 24,000 SF of the approximately 10 ft high soil berm, and stage onsite in stockpiles. Estimated volume approximately 8,900 CY.
- Excavate concrete foundations within RTA - assumed concrete foundations cover a total of approximately 100 ft by 50 ft with an assumed thickness of 24 inches. In addition, we have assumed 500 CY of miscellaneous concrete debris in the northern triangular RTA. Concrete and debris will be transported for offsite disposal/recycling. Estimated volume 900 CY.
- Excavate soil within RTA – 176,800 SF to average depth of 7 ft bgs. Estimated volume 45,000 CY
- Excavation is assumed to proceed sequentially in each cell, approximately 30,000 SF each.
- Treat excavated soil via stabilization to remove free liquids, if necessary, prior to transport for offsite disposal.

Dewatering

- Dewater each treatment cell prior to and during excavation and treat as described below. Initial dewatering of the RTA is estimated to require approximately 2 weeks (assume 200 gpm dewatering rate).
- Water volume from dewatering RTA is estimated at 2,972,900 gallons.
- Water volume from leakage through sheet pile walls and native clay layer during construction for entire RTA is estimated at 171,300 gal and water volume from rainwater is estimated at 444,000 gal.
- Total water volume is estimated at 3,588,200 gallons during construction.

Treatment and Disposal of Water from Dewatering

- Treat water from dewatering of excavations using modular treatment system during entire period of excavation.
- The modular treatment system would consist of:
  - Oil / water separator - size for effective oil and grease removal at a design flow of 200 gallons per minute for water and 10 gallons per minute for LNAPL.
  - Settlement tank(s) - size for effective TSS settlement to provide appropriate residence time in relation to the maximum flow rate and meet typical PVSC TSS criteria (250ml/L), estimated to be two 5,000 gallon polypropylene tanks.
- Discharge treated effluent to KMUA/PVSC via sewer connection.
- Sample treated effluent to monitor compliance with PVSC requirements.

Transportation and Offsite Disposal of Other Wastes

- Transport for offsite disposal/recycling concrete foundations and building debris – estimated concrete volume is 900 CY, assumed non hazardous.
- Transport for offsite disposal approximately 45,000 CY of soil from within the RTA; assumed non hazardous.
- Transport for offsite disposal/recycling 59,500 gal of LNAPL separated from water during dewatering, assumed non hazardous.
- Dispose of/recycle above waste in RCRA-permitted facilities (subtitle D).

Soil Backfill and Compaction

- Import clean soil to replace excavated soil and concrete. Estimated 45,900 CY.
- Backfill and compact.
- Following backfilling, install 2 groundwater monitoring wells in each cell such that the screens are set in the clean fill.
- Re-place excavated berm with the same soil to pre-remedial dimensions (assumed that following supplemental pre-design investigation, the material is found to be of acceptable characteristics).

Verification Sampling

- Discontinue dewatering sump operation and allow the cells to flood via surface water infiltration (may take several months).
- Sample soil and groundwater from monitoring wells, monitor for the presence of LNAPL and analyze samples for selected parameters. Assume 3 events to confirm.

Closure

- Maintain sheet pile wall around RTA but pull up from a depth of approximately 35 ft bgs to approximately 6 ft bgs, and cut the excess off just below grade. Finish grade such that a greater portion of surface water infiltration per square foot occurs in the treated area versus non-treated areas to maintain slight positive hydraulic gradient from within the treated area to the surrounding areas.

Operation and Maintenance

- None; no 5-year reviews.

Of note, air emissions from the excavation activities were estimated in order to evaluate the various regulatory requirements that may affect alternative implementation. The analytical soil results collected during the Phase 1 investigation were used to estimate an average concentration for detected VOCs. The average concentration was calculated based on detected VOC concentrations within the vertical and horizontal limits of the RTA. Partitioning calculations were performed using these average concentrations and suggest that VOC emissions during excavation activities would be below the NJDEP reporting thresholds with the exception of the emissions of 1,1-Dichloroethylene and vinyl chloride. The partitioning calculations suggest that all VOC emissions would be below the NJDEP SOTO levels and as such may not require emissions controls but will require monitoring. This will be verified during the remedial design when the emissions will be estimated for the final RTA footprint and the request for determination or a permit application (as applicable) would be prepared and submitted to the NJDEP. This FFS assumes that emissions controls would not be required (including for emissions from combustion equipment operated at the site).

Estimated Costs

The capital present worth cost for Alternative 3 is identified in the table below. The detailed cost elements are provided in Table D-1. Note that this alternative would not have operations and maintenance and periodic costs.

	Estimated Present Worth Cost	Occurs in Year
Capital Cost	$19,452,406	Year 0
O&M Cost	$0	Year 1
Periodic Cost	$0	
Total Cost	$19,452,406	--

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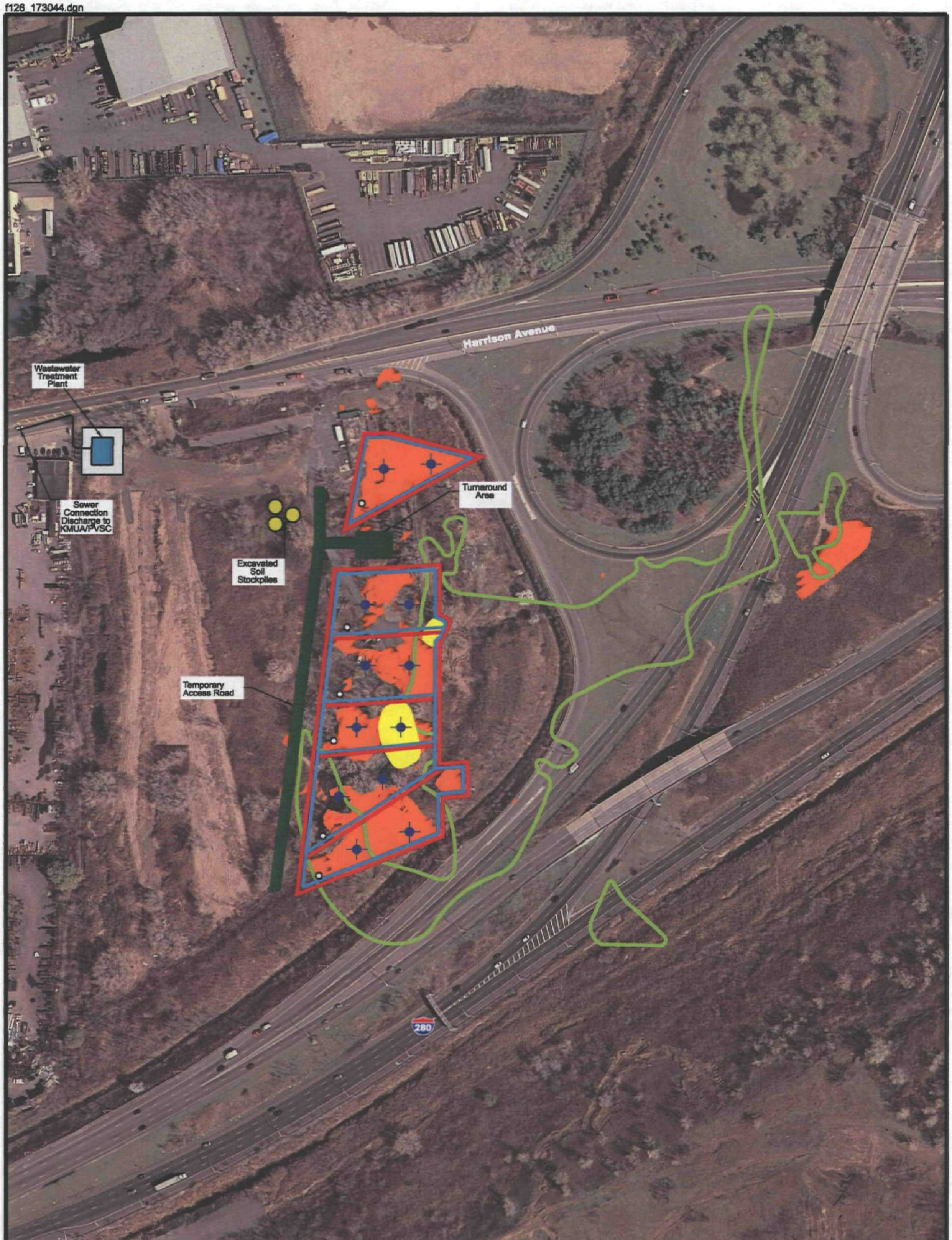

Legend

- Groundwater Monitoring Well
- Temporary Access Road
- Gravel Paved Area
- Remedial Treatment Area
- Turnaround Area
- Dewatering Sump
- Sheet Piling
- Extent of Historical Source Area (1976 Aerial Photo)
- LNAPL Plume
- Measurable LNAPL in Wells

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Figure D-1
Plan View - Soil Excavation
Diamond Head - Focused FS
Kearny, New Jersey

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TABLE D-1 Alternative 4 **COST ESTIMATE SUMMARY**

EXCAVATION AND OFF-SITE DISPOSAL AT TSDF

Site:	Diamond Head Oil Superfund Site	**Description:**	Alternative 4 consists of excavation, transportation for offsite disposal, and backfilling with clean soil of entire RTA. The project duration is anticipated to be 8 months. Capital costs occur in Year 0.
Location:	Kearny, New Jersey		
Phase:	Feasibility Study (-30% to +50%)		
Base Year:	2009		
Date:	June 4, 2009		

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
1 Mobilization/Demobilization					
Construction Equipment & Facilities	1	LS	$80,000	$80,000	
Submittals/Implementation Plans	1	LS	$15,000	$15,000	Work plan, health and safety plan, permits, etc.
Temporary Facilities	8	MO	$1,000	$8,000	Office trailers, storage facilities, sanitary facilities.
Post-Construction Submittals	1	LS	$15,000	$15,000	
SUBTOTAL				$118,000	
2 Pre-Remediation Site Work					
Clearing and Grubbing	11	AC	$3,000	$33,000	See assumptions
Fencing/Signs/Gates	440	LF	$20	$8,800	Assumes 10% of the perimeter of the site will require new fencing, signs, and gates.
Construction of Sewer Connection	750	LF	$95	$71,250	See assumptions
Construction of Water Connection	400	LF	$65	$26,000	See assumptions
Construction of Temporary Electric Service	1	LS	$25,000	$25,000	Estimate
Construction of Temporary Roads and Gravel Lay Down	67,110	SF	$0.90	$60,399	6 in thick gravel, see assumptions.
SUBTOTAL				$224,449	
3 Building Foundation Excavation					
Concrete Foundation Demolition	400	CY	$65	$26,000	
Concrete Foundation and Rubble Excavation and Hauling	900	CY	$25	$22,500	See assumptions.
Transportation / Recycle Material	1,440	TON	$16	$23,040	Vendor quote from Lewis Environmental.
SUBTOTAL				$71,540	
4 Onsite Soil Berm Excavation					
Excavation and Hauling	8,900	CY	$12	$106,800	See Assumptions.
Stockpiling	8,900	CY	$5	$44,500	
SUBTOTAL				$151,300	
5 Dewatering					
Dewatering /Leachate Sump Pumps	8	MO	$2,040	$16,320	Rental of six sump pumps operating at 50 gpm
2" HDPE Trenching and Piping	1,000	FT	$18	$18,000	1000' of leachate piping. Includes cost for trenching of pipe.
SUBTOTAL				$34,320	
6 Wastewater Treatment (for dewatering water)					
Rental of Treatment System	8	MO	$4,900	$39,200	Vendor quote from Maple Leaf Environmental. Includes mobilization costs.
Equipment Repair and Parts	1	LS	$10,000	$10,000	
SUBTOTAL				$49,200	
7 Excavation					
Sheet Pile Design and Installation	129,500	SF	$44	$5,698,000	See assumptions
Excavation and Hauling of RTA Soil	45,000	CY	$15	$675,000	Assumes entire RTA area minus building foundation, and concrete rubble and to a depth of 7 ft bgs.
Transportation / Disposal	72,000	TON	$82	$5,875,200	Vendor quote from Lewis Environmental. Includes stabilization.
Characterization sampling	45	EA	$600	$27,000	Vendor quote indicates 1 composite sample per 1,600 tons.
Stockpile RTA Soil	49,489	CY	$5	$247,445	
Sheet Pile Salvage	107,300	SF	-$11	-$1,180,300	Vendor quote from Ratto Construction. (Vendor credit). Salvage value is for sheet pile length that was pulled up and removed from site.
SUBTOTAL				$11,342,345	
8 Soil Backfill and Compaction					
Import Clean Soil	45,900	CY	$15	$688,500	See assumptions
Surface Grading	19,640	SY	$2	$39,280	Surface grading to achieve appropriate drainage
Backfilling and Compaction	45,900	CY	$7	$321,300	See assumptions
Re-place Excavated Berm	8,900	CY	$7	$62,300	
Raise Sheet Piles	3,700	LF	$184	$431,980	Raise sheet piles, sheet piles to remain in place from 6 ft bgs to ground surface. Vendor quote Ratto Construction
SUBTOTAL				$1,543,360	
9 Wastewater Disposal					
Transportation / Recycle LNAPL	59,500	GAL	$0.60	$35,700	Vendor quote from Lewis Environmental.
PVSC Fee During Construction	1	LS	$16,131	$16,131	See assumptions
KMUA Fee During Construction	1	LS	$96,058	$96,058	See assumptions
Quarterly Analytical Sampling of Discharge Water	4	EA	$2,016	$8,064	Assumes analysis through CLP, assumes quarterly sampling requires 1 day for 2 people.
Quarterly Report Preparation	4	EA	$2,016.00	$8,064	Assumes that it will require 24 hours to prepare.
SUBTOTAL				$164,017	
10 Groundwater Monitoring Well Installation					
Groundwater Wells	12	EA	$3,000	$36,000	See assumptions
Waste Disposal	1	LS	$10,000	$10,000	
SUBTOTAL				$46,000	
11 Verification Sampling					
Groundwater Sampling	1	EA	$8,064	$8,064	Assumes CLP analysis.
Analytical Soil Samples	6	EA	$120	$720	Assumes 6 samples per event for analysis of SPLP extract for oil and grease. Assumes same cost as for SPLP VOC analysis.
Waste Disposal	1	LS	$3,300	$3,300	

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TABLE D-1 Alternative 4						COST ESTIMATE SUMMARY
EXCAVATION AND OFF-SITE DISPOSAL AT TSDF						

Site: Diamond Head Oil Superfund Site
Location: Kearny, New Jersey
Phase: Feasibility Study (-30% to +50%)
Base Year: 2009
Date: June 4, 2009

Description: Alternative 4 consists of excavation, transportation for offsite disposal, and backfilling with clean soil of entire RTA. The project duration is anticipated to be 8 months. Capital costs occur in Year 0.

SUBTOTAL					$12,084	
12 Remedial Action Report	1	1	EA	$15,000	$15,000	
SUBTOTAL					$15,000	
SUBTOTAL					$13,771,615	
Contingency		25%			$3,442,904	Scope and bid contingency
SUBTOTAL					$17,214,519	
Health and Safety		2%			$344,290	
Project Management		5%			$860,726	
Construction Management		6%			$1,032,871	
Total Capital Costs					$19,452,406	

Present Value Analysis

Cost Type	YEAR		PRESENT VALUE	NOTES
Capital Cost	0		$19,452,406	This should pe the present worth of the capital costs
Annual O&M Cost	0		$0	
Periodic Cost	0		$0	
TOTAL PRESENT VALUE OF ALTERNATIVE		**DISCOUNT FACTOR (2.7%)***	$19,452,406	*Discount Factor based on OMB App C 30-year for 2009

Assumptions:

1 Pre-Design Investigation
Assumes that the cost will be similar to the Phase 2 RI costs.

3 Pre-Remediation Site Work
Vegetation will be cleared east and north of the landfill to accommodate site operations, locating facilities, and constructing temporary access roads.
Sewer connection to KMUA/PVSC sewer is based on the distance from the intersection of Harrison and Bergen Ave to the proposed onsite waste water treatment facility location. Assumes that KMUA will have completed the construction of their sewer line to which the sewer from Diamond Head will connect before the start of remedial activities. Assumes a 4 ft deep trench with pipe bedding material imported. Estimated length of piping is 750 ft, 8 in diameter.
Assumes a water connection to the 24 in water main running along the southern side of Harrison Ave. Estimated length of piping is 400 ft, 2 in diameter.
Assumes the northwest section of the site will require a gravel layer to support onsite equipment and vehicles. Assumes a new temporary road and turn around area will be required to allow access to all cells (see site plain view figures).

4 Building Foundation Excavation
Assumes existing building foundation is 100 ft x 50 ft x 2 ft. Also assumes that brick and concrete rubble located in the 0-0.5 ft bgs interval throughout triangle RTA area will be removed.
Assumes excavations and stockpiling can be completed at a rate of 1,000 CY per day.

5 Onsite Soil Berm Excavation
Assumes area of berm requiring removal is 24,000 SF with a height of 10 ft.

6 Dewatering
Pumps are assumed to dewater excavation at the rate of 200 gpm.

7 Wastewater Treatment
Includes the cost of rental of the treatment system for a period of one year. Costs are based on vendor quote for Mapple Leaf Environmental.

8 Excavation
Sheet pile wall covers boundary of RTA and four partitions to a total of 3,700 lf. RTA divided into approximately 30,000 SF cells as shown in the plan view figure. Assumes AZ36 Sheet Pile and A572 Grade 50 Steel will be used. Vendor quote from Ratto Construction. Quote is for leaving sheet pile in place. Separate line item included for pulling sheet pile up and cutting off below ground level.

9 Soil Backfill and Compaction
The imported clean soil volume is based on the volume of excavated soil plus the volume of comcrete foundations and debris.

10 Wastewater Disposal
Refer to Table in Appendix A for basis for LS.

10 Groundwater Monitoring Well Installation
2" wells, 2 wells in the northern area, 10 wells in the southern area

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